PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY of BRITISH COLUMBIA

Vol. 58. **Issued December 1st, 1961**

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A METHOD FOR TESTING LOW-VOLUME ORCHARD SPRAYERS[1]

J. M. MCARTHUR[2] AND D. B. WADDELL[3]

Introduction

A low-volume sprayer using a 110-125 mile per hour airstream to carry the pesticide was developed at this laboratory for the control of orchard pests (2). This sprayer greatly reduced spraying time and labour. After the practicability of the sprayer had been demonstrated, a number of commercial versions appeared. Some of these were very good but others were inadequate. This resulted in a demand for sprayer assessments to ensure that the orchardist could get satisfactory equipment. The object was then to develop a sprayer testing procedure for two purposes: determining the effect of sprayer modifications designed to improve spray distribution and assessing commercial sprayers.

To test sprayers in the field, many acres of orchard and large amounts of time, manpower, and materials are required. It was obvious that the demand could not be met with field tests. On the other hand, although much development work had been done in the laboratory, the amount of information that would be obtained this way was limited and far short of that required. The solution appeared to be a method intermediate between those of the field and the laboratory.

Frame for Sampling Spray Deposits

It was decided that the most practical approach was full scale tests, *i.e.*, to measure deposits at distances normally encountered in orchards. Therefore, it was desirable to have a convenient method of obtaining spray deposits at heights up to 25 feet and horizontal distances up to 15 feet. To achieve this, a wooden frame was built upon which could be placed various sampling devices (Figure 1). The frame was 30 feet in height and width. On the back of the frame were 3 plank walks, 6, 14, and 22 feet above the ground. A ramp led from the ground to the three walks.

At heights of 5, 10, 15, 20, and 25 feet, lengths of angle iron were bolted to each end of the frame and extended 18 inches out from the front. A 7-inch length of strap iron was bolted to the end of each angle iron so that it would be at 90° to a line from the midpoint of the sprayer vent (Figure 2). Two galvanized wires, 1/16 inch in diameter, were fastened to the strap iron by heavy springs. The wires were 3 inches apart and sheet aluminum spacers were fastened to them midway between the sampling points to maintain the 3-inch spacing along the 30-foot length. Each sampling position was marked by a short length of string tied to the lower wire (Figure 3). There were 6 sampling positions, 5 feet apart, the end positions being 2.5 feet from the angle-iron brackets.

Sampling Surfaces

Microscope slides, 1 by 3 inches, were used to collect spray deposit samples. To increase the spray holding capacity of the slides, they were put in a silicone preparation[4] for about 3 minutes and then placed on a rack to drain and dry.

The slides were held on the wires on the spray frame by clips made as follows. A piece of 3- by 3.5-inch tinplate was turned over on two edges to form a clip 3 by 3 inches. The sili-

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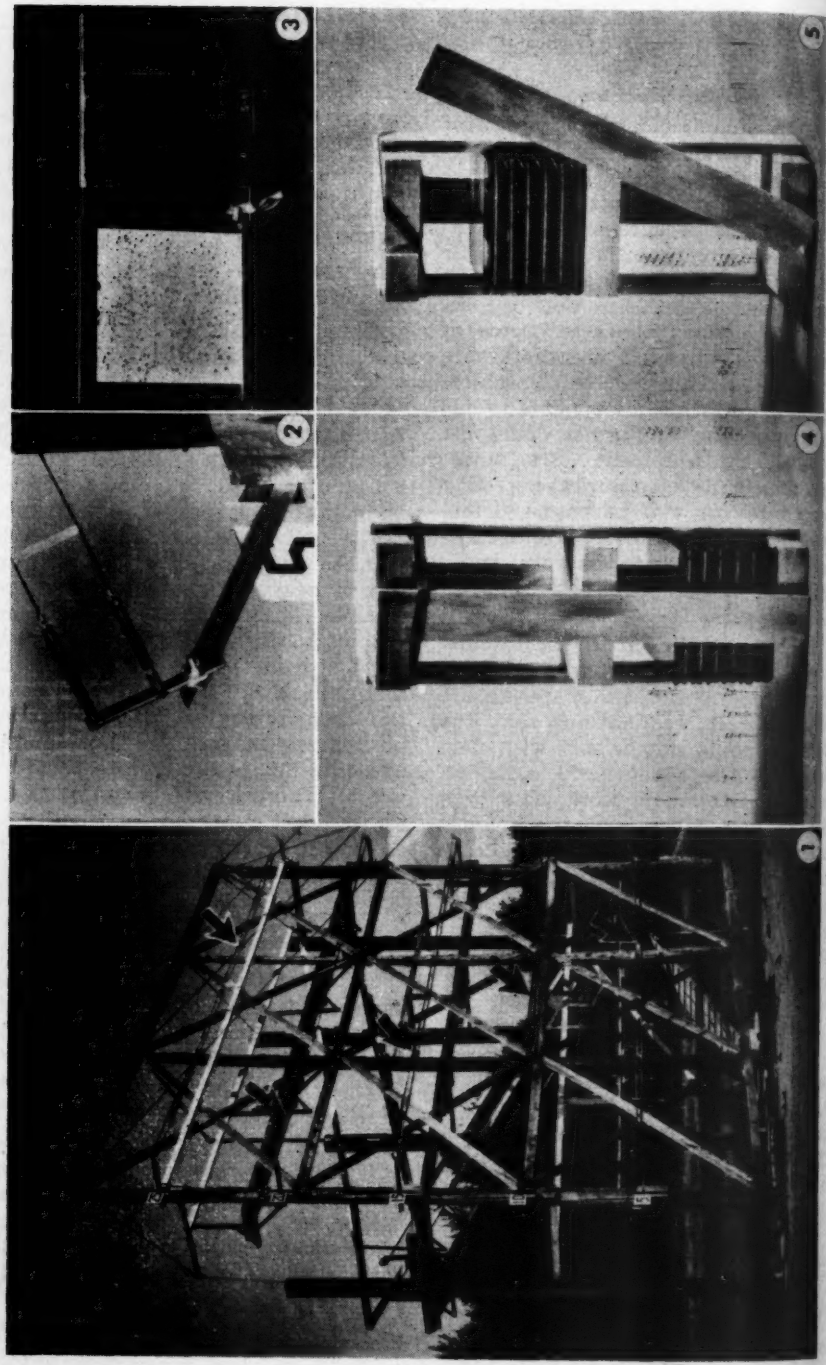
[3] Entomologist; now with Canada Department of Agriculture, Research Branch, Ottawa.

[4] Xpandoseal with Silicone, Xpandoseal Corporation, 43-15-36th Street, Long Island City 1, N.Y.


3
5
2
4
1

cone-treated slide was fastened to the clip with rubber cement. Two spots of cement were placed on the clip and on the back of the slide and allowed to stand a few minutes until tacky; and then the slide was placed on the clip so that the spots on the clip and slide were in contact (Figure 3).

Waxed cards were also used to collect samples. These were made from 5- by 3-inch plain index cards that had been immersed for a few minutes in a solution of 15 gm. of paraffin wax in a litre of petroleum ether. When dry, the cards were cut into 2 pieces, 2.5 by 3 inches. These fit between the folded edges of the metal clips (Figure 3). A small amount of rubber cement was placed on the centre of the clip to hold the waxed card securely. When the cement was tacky the card was slipped into the clip and pressed firmly against the cement.

For convenience in handling, the cards and slides were carried in 2-compartment boxes (Figures 4 and 5). The unsprayed cards and slides were placed in the lower compartment, the sprayed in the upper. The turned edges of the clips allowed the sprayed cards and slides to be stacked without smearing the deposits. For each sampling height, one box with 6 cards and 6 slides was required, *i.e.*, 5 boxes, 30 cards and 30 slides for each test.

At each sampling position, the card was placed on the wires before the slide; otherwise the slide would drop off. Those at 5 feet from the ground were put into position from the ground; those at 10 feet from the 6-foot walk; those at 15 and 20 feet from the 14-foot walk; and those at 25 feet from the 22-foot walk. The slide was removed before the card.

Test Solution

A solution of rhodamine B[5] dye in water was used as the spray liquid. For most sprayer tests, 30 gallons of spray was sufficient. The dye solution was prepared by dissolving 90 gm. of rhodamine B in approximately 250 ml. of methanol. This was then added to 30 gallons of water in the sprayer tank and mixed.

Wind Velocity and Direction

The sprayer testing was done outdoors when the wind velocity was less than 2 miles per hour. Wind direction and velocity were measured during a test because variations affected spray deposits. These measurements were made 12.5 feet above the ground on a small platform 30 feet in front of the spray frame.

Wind direction was determined by means of a simple aluminum wind vane mounted on a wooden dial marked in 10-degree divisions. The dial was set up so that the 0-180 line was parallel to the spray frame. Thus wind direction was recorded in relation to the frame.

Wind velocity was measured by means of an anemometer[6] and a velometer[7]. These were mounted so that they could be pointed in the direction from which the wind was blowing. The anemometer was started at the beginning of the test run and stopped

[5] Rhodamine B-500, Canadian Industries (1954) Limited, 355 Burrard Street, Vancouver 1, B.C., Canada.

[6] Taylor Instrument Companies, Rochester, N.Y.

[7] Illinois Testing Laboratories, Inc., Chicago, Ill.

Fig. 1.—Frame for collecting spray samples. On the back are the ramp and walks with white guard rails. Brackets carrying wires for holding sampling surfaces (arrows) are arranged at 5-foot intervals above the ground.

Fig. 2.—Bracket with spring-loaded galvanized wires on which spray targets are placed. One of the spacers to keep the wires 3 inches apart is shown at top centre.

Fig. 3.—Sprayed waxed card and microscope slide in place. The two darker areas on the slide are cement. The string on the lower wire marks the sampling position.

Figs. 4 and 5.—Two-compartment box containing stacked cards and slides for one sampling height, before and after a test, respectively.

at the end. The air movement was recorded in feet but, as the run was timed, the velocity could be calculated. The operator noted the variation in air movement shown by the velometer. If a wind gust occurred during the spraying period, it was noted and also the position of the sprayer in relation to the frame. As the spraying time in a test run was approximately 30 seconds, gusts occurred in few runs.

Spraying Procedure

The course the tractor was to follow when pulling the sprayer past the frame was marked on the ground with heavy white cord. The course varied depending upon the information wanted. For example, if the effect of a sprayer modification on deposit at one distance was wanted, the course was parallel to the frame. However, if information was wanted on deposits at various distances, as for sprayer assessment, the course was at an angle to the frame. In this case the course was marked so that in the test the mid-point of the sprayer vent passed 15 feet horizontally from the first sampling positions and 5 feet from the last. The tractor and sprayer were driven over the course and the throttle setting for the desired speed was determined. The speed was usually 1 mile per hour but speeds up to 4 miles per hour have been used.

The cards and slides were placed on the frame. When the sprayer was in position, the wind observer ready and air conditions satisfactory, the sprayer was drawn along the marked course. When the sprayer vent passed a point 10 feet before coming into the path of the spray frame, the person in charge gave a signal and started a stopwatch. At the signal, the sprayer operator turned on the spray and the wind observer started the anemometer. Similarly, the spray and instruments were stopped when the sprayer was 10 feet past the frame. The duration of the test, pump pressure, and velocity and direction of air movement and other pertinent items were recorded.

Slide and Card Treatment

As soon as spraying was complete, the targets were removed and stored in the carriers (Figure 4) until dry. Then the slides and cards were removed from their metal clips with a thin-bladed spatula. The cement was removed from the backs of the slides by rubbing with the fingers or a cloth. The slides were stored in microscope slide boxes. A 1- by 2-inch piece of each card was glued on a 12- by 15-inch sheet of black photograph-album paper in the same relative position as on the spray frame (Figure 6) and filed.

To determine the spray deposit, the dye was washed off the slides with water. This was done by placing the slide in a 8-ounce bottle, 2 by 2 by 5¼ inches, and adding 15 ml. of water. The tightly capped bottle was then placed on its side in an oscillating shaker and gently shaken for 5 minutes. The solution was decanted and the absorption measured in a spectrophotometer at 555 millimicrons or in a colorimeter with a green filter transmitting in the 500 to 570 millimicron range. A sample of spray solution taken from the sprayer tank was diluted to 100 times its volume and the absorption measured. The deposit on the slide was calculated as microlitres of spray per square centimeter.

Discussion

Frame for Sampling Spray Deposits

Originally it was planned to erect a structure that would have a resistance to a spray stream somewhat similar to that of a mature apple tree. For this purpose the frame was covered with lath snowfencing. However, the resistance was very high; there were practically no deposits on surfaces behind the fencing. Other

materials such as netting with various materials fastened to it were considered. Finally, it was decided to use the simple frame instead of a more elaborate structure.

Placement of Sampling Surfaces

The next step was to determine where the spray sampling surfaces should be placed on the frame. By means of an anemometer and small wind vanes the behaviour of airstreams around the frame was examined. In the areas between the structural members of the frame there was considerable air disturbance, but none 12 inches or more in front of the frame. Therefore the sampling surfaces were placed 18 inches in front of the frame. The thin wires used for carrying the surfaces created a negligible amount of disturbance in the airstream and the amount of sag was slight.

When the sampling surfaces were placed vertically, a considerable quantity of spray deposit was blown off by the airstream. Also, because the angle of the sampling surface to the spray stream varied with the position on the frame, it was necessary to calculate the deposits on the basis of a common angle. The deposits on cards could not be corrected and were of little or no value under these conditions, but by tilting the sampling surfaces so that each was at right angles to the spray stream this problem was overcome.

Test Solution and Sampling Surfaces

The information wanted for each sampling point on the frame was the quantity and type of spray deposit. As it was desirable to determine a large number of deposits quickly, a water-soluble dye was used and the amount determined colorimetrically. Rhodamine B was used because its high absorption at a wavelength of 555 millimicrons permits small deposits to be determined. Most materials absorb the dye and are unsuitable for sampling surfaces. However, the recovery of measured amounts of dye from glass was excellent, and microscope slides were used. The slides were treated with a silicone preparation to make the surface hydrophobic. This increased the water-holding capacity. Silicone preparations for treating laboratory glassware are not suitable because they give a very smooth surface from which much of the spray deposit is blown off by the sprayer airstream. Paraffin wax and petroleum oil were also tried but were less convenient and the surface was easily damaged. The silicone preparation finally used produced a satisfactory surface and the slides could be used several times before requiring retreatment.

Cleared photographic film was also tried and is satisfactory for determining small spray deposits. The gelatin layer absorbs the dye as a solution and in this form the amount present can be determined directly by measuring the light absorption in a photoelectric colorimeter. Because the dye solution is not continuous in the gelatin, a colorimeter should be used that measures absorption over an appreciable area of the film. The Klett-Summerson photoelectric colorimeter[a] was found satisfactory. Two sizes of film have been used, 1 by 3 inches and 1¾ by 3 inches. With the smaller size 2 absorption measurements were made, 1 on each end; with the larger, 4 measurements were made, 1 in each quarter. The mean value was used for calculating the spray deposit. The absorption could be measured almost immediately after spraying without processing. However, there is a disadvantage in using film. Because the hydrophilic gelatin surface has a low spray-holding capacity its use is limited to small spray deposits. Dye deposits on other transparent materials, such as glass and

[a] Klett Manufacturing Co., New York, N.Y., U.S.A.

plastics, cannot be measured in this way because the spray solution dries and the dye separates as a solid. For this method the dye must be in solution in a transparent medium.

The amount of material per unit area is not the only factor in assessing spray deposits. The fraction of the sprayed surface covered is of equal, if not greater, importance. Of a number of materials tried for surfaces to assess coverage, plain index cards impregnated with paraffin wax were the most satisfactory. The treatment described gave the cards a smooth, hydrophobic surface upon which droplets of rhodamine B solution left sharp, circular stains. An attempt to measure the spray coverage on the cards by reflectance was not successful. Visual estimation of coverage has been found satisfactory for practical purposes. The majority of sprayers tested by this method delivered spray at approximately 2 gallons per minute and travelled between 1 and 2 miles per hour. Under these conditions there is considerable coalescence of droplets on the waxed cards and they could not be used for determining droplet sizes. However, when the spray deposit was light, drop spectra could be determined from the ratio of stain to droplet diameter. Coalescence of drops on the cards could be detected visually with some experience. Very large spray drops could be detected also as they tended to fall out of the airstream and struck the targets at an acute angle making a distinctive elliptical stain.

Both the waxed cards and the microscopic slides had to be cemented to the metal clips. Although the folded edges of the metal clips held the dry cards snugly, sprayed cards bulged and fell out unless cemented to the clips. As the cards and slides are removed from the clips after the spraying, the cement must hold the targets firmly during the test but give a bond that can be readily broken. Rubber cement for paper is suitable if the surfaces are placed together when the cement is tacky but not dry. This cement has a further advantage in that, when dry it can be readily removed from the surfaces by gentle rubbing. The sampling surfaces may be damaged if touched by the fingers and drop stains are obscured. When the waxed card was pressed onto the cement, it was protected with a piece of card. When a slide was cemented to a clip, the cement had to be applied to both surfaces to obtain a satisfactory bond. Also, the slide had to be bonded at 2 points (Figure 3) or the blast of the airstream occasionally spun the slide or blew it off. Before the deposit on the slide was determined the cement had to be removed because it absorbed the dye.

Assessing Deposits

The number of microscope slides used for measuring deposits depended upon the volume of spray. For sprayers applying 50 to 100 gallons per acre, 1 slide was used at each sampling position at heights of 5, 10, 15 and 20 feet and 2 slides at 25 feet. Where smaller quantities of spray were applied more slides were used.

Preliminary experiments were made concerning the course of the spraying run. In each experiment 4 runs were made. In 2 runs the course was 15 feet horizontally from the first sampling positions and 5 feet from the last. In the other 2, the course was 5 feet from the first sampling positions and 15 feet from the last. The means of the 4 runs for 3 experiments were given by Cox (1, pp. 26-33). The data indicated that greater precision would be obtained with 3 runs along the course starting at 15 feet from the sampling positions and ending at 5 feet than with the 4 runs used in the experiments.

Equal amounts of deposit at all sampling positions might be considered ideal. However, this is not the

case. The spray frame is 2-dimensional whereas a tree is 3-dimensional. Horticultural practices affect distribution of the deposits in the tree. In British Columbia, apple trees are usually planted 30 feet apart. They are heavily pruned, and open in the centres. Mature trees almost touch their neighbors and are approximately 20 feet high. Under these conditions the sprayer vent passes under the outer edge of the tree. Since the work was directed toward obtaining efficient pest control in British Columbia orchards some of the conclusions may not apply in other areas.

The deposits on the sampling surfaces give information on the distribution of the spray in the airstream. An even distribution of spray in the airstream is not ideal. The airstream expands as it travels out from the sprayer vent so that the shape in vertical section is approximately that of a right-angled fan. The shape of the tree above the trunk is roughly cylindrical and a plane vertical section through the tree is approximately a rectangle. The vertical columns of targets then correspond to vertical lines through the rectangles. These points should be kept in mind when one scrutinizes data obtained on the spray sampling frame.

If the deposits on the sampling surfaces at the 25-foot height were small the top deposits in trees were small. These deposits could be increased by increasing the amount of spray in the upper half of the airstream. However, the amount of spray in the top portion of the airstream should not be high because this portion travels almost vertically and has a comparatively small part of the tree to spray. If the surfaces at the 5-foot level 5 feet from the sprayer were sprayed to the point of run-off then the spray deposit on the parts of the tree nearest the sprayer were high. If the surfaces near this position were also flooded, then a larger portion of the tree was heavily sprayed. In a well-adjusted sprayer the greatest deposit for any level fell approximately on a diagonal line from the nearest position on the 5-foot level to the farthest position on the 25-foot level. The portion of the spray stream sampled on this diagonal was the portion that sprayed from the lower outside of the tree to the top centre. This part of the stream had to carry the greater portion of the spray because it sprayed a greater portion of the tree. Orchard tests showed that the sprayers that gave good spray distribution in trees also gave nearly uniform spray deposits on the frame at distances of 11 to 13 feet.

In Figure 6 are shown waxed-cards sprayed by a sprayer as received from the manufacturer and after modifications had been made to give a better deposit distribution. The spray output in the 2 tests was the same, 2.24 imperial gallons per minute. The larger stains on the more heavily sprayed cards are formed by coalescence of drops on the cards. In the right-hand group, there has been little or no coalescence of drops on the left-hand 25-foot level card. On the next 2 cards to the right some coalescence has taken place. The larger stains surrounded by comparatively clear areas, on these 2 cards, are distinctive of coalesced drops. There has been coalescence of drops on all cards in this set with the exception of the 1 on the upper left. The spray did not contain any coarse drops. These would be detected as large oval stains present in greater concentration on the lower cards than on the upper.

Figure 7 shows the deposits obtained on the spray sampling frame and on the foliage of mature apple trees. The sprayer used applies 70 imperial gallons per acre and has given good control of insect pests in British Columbia. It is evident that there are

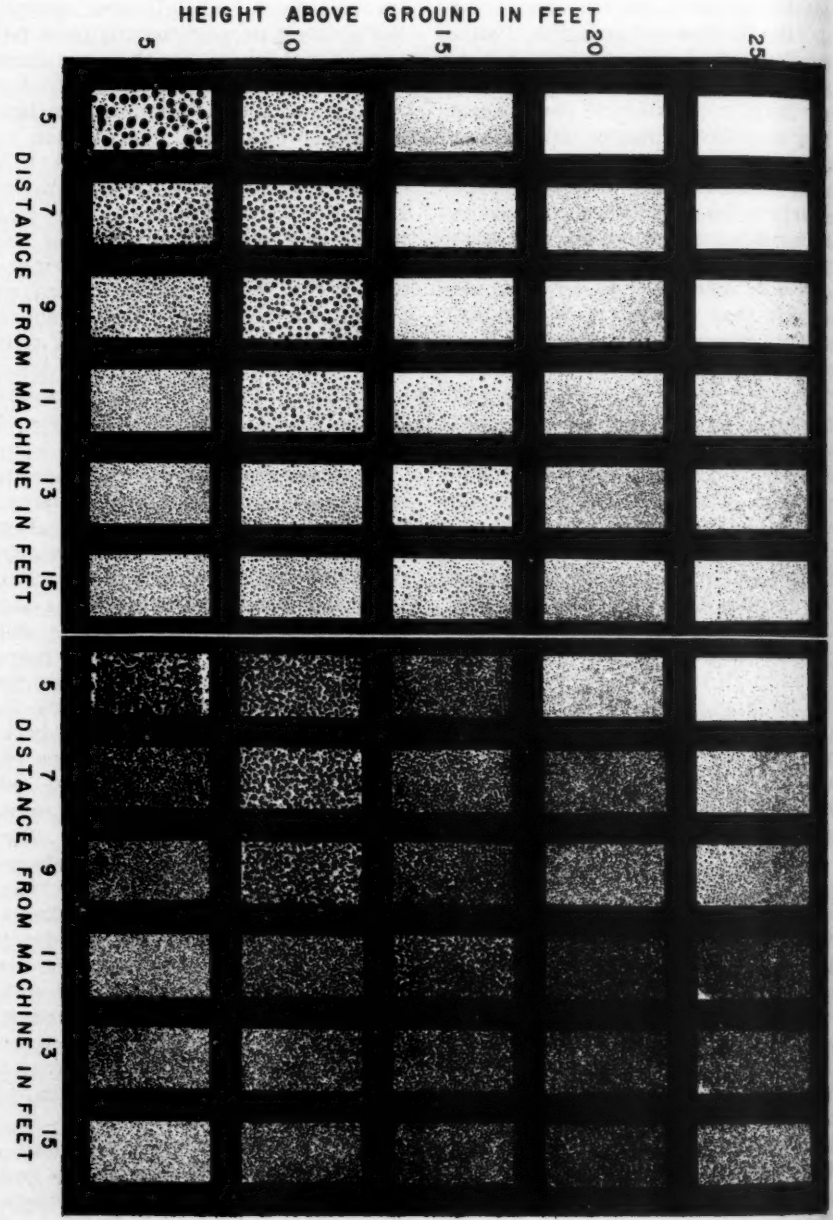


Fig. 6.—Mounted sprayed wax-card targets mounted for reference. Upper a poor spray distribution; lower, good.

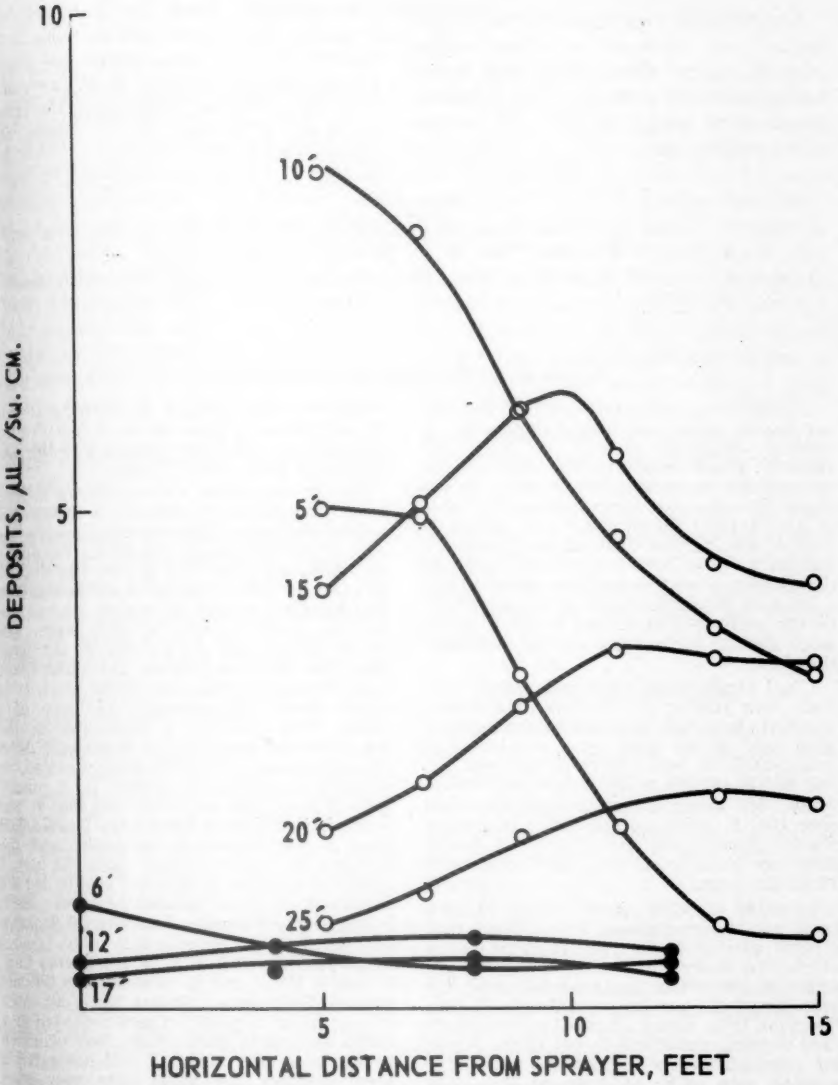


Fig. 7.—Spray deposits, 5 upper curves on spray sampling frame at 5-, 10-, 15-, 20-, and 25-foot heights; 3 lower curves on mature apple trees at 6-, 12-, and 17-foot heights.

large differences between the frame and tree deposits. Nevertheless, when the correlation between frame and tree deposits is known, the efficacy of a sprayer in the orchard can be predicted from the frame data with considerable accuracy.

Abstract

A method is described for full-scale testing of orchard sprayers with outputs up to 100 gallons per acre. Performance is assessed from deposits obtained on waxed cards and treated microscope slides.

Acknowledgment

The authors thank the staffs of the Chemistry and Entomology sections, Summerland, B.C., for suggestions and assistance in carrying out tests, G. F. Lewis and G. D. Halverson for constructing the spray frame and S. R. Cannings for taking the photographs.

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A Note on Catching Insects at a Small Pool

In 1960 I was very successful in collecting insects when I sat over a small pool on several occasions during the very hot summer. I had caught several good species at the same place in previous years. It was much the same as sitting over a water hole in Africa, but with an insect net instead of a rifle, and in the heat of the afternoon instead of just before sundown. I found that insects of certain families seem to need a drink in the hottest part of the afternoon on the really hot days. The hotter it is the more anxious for a drink and the less alert they are.

I had lunch about noon and rested until 1:30, then started out for the pool, which is a little less than two miles from home, a good half of the walk up a side-hill that faces south. It was generally between 90° and 95° F. on the north wall of my house when I left home so it must have been well over 100° F. going up the hill. I told some friends about it and one remarked I should have my head examined, for I was over 76 at the time.

I wanted to catch species of the Stratiomyid genus **Euparyphus,** but I found that several species of Therevidae came for a drink just as readily as the Stratiomyids, although Therevidae are reported to be dry area flies. I also caught some Tabanids. The flies took little notice of me. Apparently all they worried about was to get to the water for a drink. The bottom of the creek was covered with rocks of different sizes and when I put my net over a fly it would just walk or fly through one of the openings caused by the net being held up by rocks. I was very discouraged at catching so few in proportion to the number I had the net over and should have bagged had the surface been more nearly level.

On the way home I remembered making a very small net years ago to catch flies around the house. That evening I made one with a rim 5 inches in diameter. The frame was of baling wire; the handle was the two strands of wire twisted tightly together. The handle was only 10 inches long so you can tell how "tame" the flies were. The small net did not get so wet as the large one. The Stratiomyids in particular liked to go directly to the edge of the pool, or to climb down the perpendicular face of a small rock standing a little out in the water. It was funny to see them walk down this perpendicular rock; they waddled, or perhaps backpeddled, down it. I missed quite a few with the small net, but it was much better than a large one. I could just clap it over some of the rocks and the trapped fly had to climb into the net. I caught several horse flies but had to use the large net for these as they were very alert. I caught two **Tabanus rhombicus** O.S. males and one **Tabanus agrotus** O.S. male, besides **Euparyphus crotchi** O.S., **E. crucigerus** Coq., **E. major** Hine, and **E. latelimbatus** Cn. and several **Scoliopelta luteipes** Will., all more or less flying together. There were ten or a dozen species of Therevidae, four of which were not in the C.N.C. I did not catch a great number but most were very good finds. I shall be watching that place next year.

—*H. R. Foxlee, Robson, B.C.*

NOTES ON THE CHEMICAL CONTROL OF ECTROPIS CREPUSCULARIA SCHIFF, AT KITIMAT, B.C.[1]

G. T. SILVER[2]

The saddle-backed looper, *Ectropis crepuscularia* Schiff., has not been regarded as a serious defoliator of hemlock stands in coastal British Columbia, and there is only one record of damage in the Interior. Populations started building up in 1951 in the hemlock-cedar stands of the North Thompson River Valley, and in 1953 nearly all the ground cover plants in the Thunder River area were completely defoliated. The population declined in 1954 with no apparent damage to overstory trees.

The saddle-backed looper then remained at a low level in British Columbia until 1958 when larvae became common in Forest Insect Survey collections. The population build-up continued in 1959, but there was no indication of an impending outbreak. A heavy moth flight was reported at Kitimat in May, 1960, and by the end of July hemlock stands at Kitimat were severely defoliated.

Only the general life history of this species is known. The moths emerge in early or mid-May, mate, and lay eggs. The larvae apparently feed on the understory and ground-cover plants before moving to the larger trees. In August the larvae drop to the ground and pupate in the duff beneath the trees, where they overwinter.

The full-grown larvae are about 1¼ inches long. The head is brownish, often mottled. The body is dark grey to brown, sometimes reddish in colour. The first three instars have a distinct inverted V marking on the dorsal side of the 2nd abdominal segment, but this marking becomes indistinct and is often missing in the last instar. The light grey moth has a wingspan of about 1¾ inches. The general mottled and indistinct markings of this species makes identification difficult. The wings appear to have scalloped edges and many fine transverse lines, often poorly defined.

The number of larval instars has not been definitely established. About 1,400 larval head capsules collected in the fall of 1960 were measured and plotted. When these data were combined with rearings conducted during the winter there appeared to be five instars. However, three of 16 larvae reared individually through to maturity had six instars. More work will be required to resolve the number of instars; the discrepancy could be a sex difference or a result of forced rearing.

Extent and Intensity

Heavy defoliation extended from about two miles south of the Smelter site to about three miles north of Kitimat Station, and from the Kitimat River westward up the mountain slopes to about 1,500 feet. All merchantable timber in the Anderson and Moore Creek valleys was also heavily defoliated. The total area was 10,500 acres, and was remarkably well defined. There was no gradual decrease in defoliation or number of larvae towards the edge of the infestation but rather an abrupt line, in places only ¼ mile wide, separating infested and non-infested stands. The area of heavy population coincided remarkably well with the extent of the "fume" cloud from the smelter. The reason for this is not understood yet.

With few exceptions the undergrowth, including devil's club, elder-

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berry, and other deciduous bushes was defoliated. Most of the coniferous reproduction, regardless of species, was completely stripped. Defoliation was heaviest on the southern slope of Sand Hill, and the northern slopes of Anderson and Moore Creek valleys, all southern exposures. This species feeds from the forest floor up, and feeding was stratified to the extent that when defoliation was heavy in the upper third of the crown of intermediate trees feeding was also heavy on the lower and mid-crowns of co-dominant and dominant trees. This pattern is illustrated in Table 1 which summarizes data from one of six plots examined in the infestation area.

TABLE 1—Ocular estimate of defoliation caused by saddle-backed looper in Fume Plot 2. Anderson Creek, Kitimat, B.C. September, 1960.

Tree species	Crown class	No. trees	Average defoliation by crown levels (%) Top ⅓	mid ⅓	lower ⅓	Total	No. trees 100% defoliated	No. Trees 70-99% defoliated
Hemlock	Dom	4	38	46	73	51	0	1
	CoD.	3	39	52	77	52	0	1
	Int.	5	81	81	81	81	3	1
	Sup.	4	100	100	100	100	4	0
Balsam	Dom.	1	50	80	100	80	0	1
	CoD.	7	14	31	47	29	0	0
	Int.	5	81	92	92	91	2	2
	Sup.	10	100	100	100	100	11	0
Cedar	Dom.	1	0	0	10	3	0	0
	CoD.	3	0	2	13	4	0	0
	Int.	2	8	35	55	30	0	0
	Sup.	1	30	30	10	30	0	0

Chemical Control

In an effort to prevent further defoliation to the stands bordering the highway and facing the townsite it was decided on July 29 to spray. Approximately 1,800 acres were sprayed on August 1 by a Grumman Avenger aircraft from Skyway Air Services, Langley. Dosage was ½ lb. of DDT per U.S. gallon of fuel oil, applied at the rate of one gallon per acre. Lack of time did not permit the organization of a proper appraisal, but 32 one-tree sample stations were established in the spray area, and 10 check trees were established outside the spray area. All samples were from reproduction trees or the lower crown level of larger trees which could be reached with clippers from the ground. Two 18-inch branch samples were taken from each tree at each sample date, measured, and the larvae counted. Population was expressed as number of larvae per 10 square feet of foliage surface. Spray deposit cards were set out at each station, and were analysed by the Chemical Control Section, Forest Entomology and Pathology Branch, Ottawa.

The amount of DDT recovered was considered adequate at only two stations where the deposit was 0.28 and 0.29 gpa (Table 2.). The average survival at these stations after 24 hours was 21.4 per cent, but increased to 65.5 per cent 48 hours after spraying. No larvae were found after seven days, but overwintering pupae averaged three per square foot of duff, indicating that some larvae survived. The percentages of larval survival for the other stations are shown in Table 2. In many cases more larvae were found 48 hours after spraying than before spraying. It was impossible to obtain larvae at some stations after seven days because the trees were completely defoliated, and the larvae had left the trees.

TABLE 2—Percentage survival of saddle-backed looper larvae and estimated DDT spray deposit. Kitimat, B.C. 1960.

Number of stations	Deposit gpa	Percentage survival 24 hrs.	48 hrs.	7-10 days	No. pupae per sq. ft. of duff
2	0.28	21.4	65.5	0	3.0
8	0.03-0.09	84.5	47.0	74.2	15.2
22	less 0.01	83.6	93.7	—	6.7
10	check	95.2	95.0	38.5	12.1

From the standpoint of larval mortality the operation does not appear to have been very successful. However, during a survey by helicopter in October it was observed that the trees within the spray area appeared to be in better condition than the unsprayed stands, so that the operation is believed to have saved a considerable amount of foliage.

Several possible explanations for the high larval survival are: the advanced stage of the larvae at the time of spraying, insufficient dosage of DDT, and the insects' habit of feeding from the ground cover up.

On July 31, 76.4 per cent of the larvae were in the ultimate instar, and 22.7 per cent in the penultimate instar. There was some indication that the younger instars were more susceptible to DDT as the percentage of larvae in the last instar increased at the spray stations whereas the distribution of larval instars did not alter greatly in the check stations.

The recovery of DDT at the 32 stations indicated that coverage was neither heavy nor uniform. Only two stations recorded a deposit heavy enough to be effective, 0.28 and 0.29 gpa. Eight stations received from 0.03 to 0.09 gpa, and the remaining 22 stations received less than 0.01 gpa. Some of the reason for the low DDT recovery could be that as *Ectropis* feeds from the ground cover up most of the upper crown levels were not defoliated, and a large portion of the spray would be caught and held in the tree crowns. Nevertheless the amount of spray deposited after allowing for foliage screening was still very small. It could be significant that the two stations receiving the heaviest dosage were on the edge of stands. The feeding habits of the larvae thus offer them a certain amount of protection, and this presents a difficult problem of obtaining spray penetration through a dense, undefoliated forest canopy to where the larvae are feeding. This problem is even greater if spraying is conducted during the early instars when larvae are still on the understory plants and not on the overstory trees as was the case during 1960 at Kitimat.

An hour after spraying was completed thousands of larvae were observed dropping by silk threads from the trees. By afternoon the larvae were crawling up the trees again and few dead larvae were observed. Larvae continued to drop the day after spraying; two days after spraying larval drop was still quite heavy but many of the larvae were free-falling, i.e., not on silk threads. Larvae on the ground were sluggish and many appeared unable to crawl back up the trees.

The assumption is that as larvae continued feeding after the initial knockdown and returned up the trees they were exposed to more DDT in the upper crown levels and gradually accumulated a lethal or sub-lethal dose of insecticide causing them to drop again to the ground and understory. This would also explain the large numbers of larvae counted on the lower crown levels on the second day after spraying.

The high survival of the looper is clearly shown by the large number

of pupae per square foot of duff found in October, 1960 (Table 2). Pupal samples within the infestation area averaged 7.8 per square foot of duff. There was no significant difference in the number of pupae inside and outside the area sprayed in 1960. Barring any unforeseen mortality a heavy population is expected in 1961.

The author wishes to acknowledge the assistance given by the District of Kitimat and the Aluminum Co. of Canada during this work.

MYZOCALLIS WALSHII MONELL (HOMOPTERA: APHIDIDAE) ON RED OAK AND A METHOD OF CONTROL[1]

PETER ZUK

Introduction

The aphid *Myzocallis walshii* Monell is a major nuisance on the red oak, *Quercus borealis* Michx. f. (*Q. rubra* auth.), a boulevard tree in Vancouver.

The aphids excrete large amounts of honeydew which falls as droplets over the leaves and eventually on sidewalks, lawns, and cars parked beneath the trees. Another objectionable feature is the sooty mould that grows on the honeydew. Repeated sprayings are necessary to alleviate the nuisance.

During the 1930's the red oak was commonly planted as a boulevard tree in Vancouver. In recent years, the Parks Board, who are responsible for planting and maintaining these trees, have planted smaller flowering species in preference to the larger oaks, maples, horse-chestnuts, catalpas and birches. Another reason for this change was that the red oak in particular supported a dense population of the aphids.

This paper deals with investigations on the life-history and control of this aphid in Vancouver.

Biology

M. walshii has been recorded on the leaves of various oaks (*Quercus alba, Q. bicolor, Q. imbricaria, Q. palustris, Q. rubra, Q. velutina*) (2), and hickories (*Carya* spp.) (1). It has no alternate host.

During the two years of this study, apterous viviparae appeared in the first week in June, when honeydew was found on the leaves on the high branches. A few alate viviparae were found on the lower leaves about the middle of June. The numbers of aphids increased slowly until the second or third week in July after which there was a rapid increase. In 1960, the peak was reached in the first week of September. The previous year there were two peaks: in the middle of July and at the end of August. At the peak of the infestation average counts in untreated trees ran as high as 54 alatae, 107 apterae, and 343 nymphs per leaf. At this time, the honeydew could actually be seen as it fell.

In late September and early October eggs were laid upon the bark of the larger limbs, and on the trunk in the vicinity of the first crotch, in which area the bark was rough, but not so rough as on the trunk below. Distally the limb bark was smooth. After the apterous oviparae had mated with alate males they moved from the undersides of the leaves to the crotch area where they deposited eggs in the cracks of the bark. In 1961, the eggs hatched in the middle of May.

CONTROL EXPERIMENTS

Materials and Methods

The experiment was conducted on mature red oak trees in plantings of

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16 trees per city block. Di-Syston[2] was applied in the third week of May by two methods: the granules were (a) poured into 24 holes in the soil each 4 inches deep, spaced around the periphery of the tree, and the holes plugged with soil; (b) the granules were buried at a depth of 4 inches in a trench next to and surrounding the trunk of the tree. The material was used at three dosages: 5 oz., 10 oz., or 15 oz. per tree. The treatments were set out in random arrangement and replicated four times. The trees in Block I were treated in 1959 and again in 1960 by method (a). Trees in Block II were treated in 1960 at the three dosages. Of these four trees receiving each dosage, two were treated by method (a) and the other two by method (b).

Counts of adult aphids on ten leaves per tree were made at weekly intervals, commencing in the first week in June. In the experiment on Block I, aphid counts from two trees were very low, perhaps because these two trees had been treated with Di-Syston in 1958. Missing data therefore were calculated for these two trees according to the method of Yates (in Snedecor (3)) for inclusion in an analysis of variance.

The circumference of the trees was measured three feet above soil level.

Results and Discussion

Since spray drift and spray residues might be hazardous to children and pets, to birds and their nestlings, and to predatory and parasitic insects, a systemic insecticide that can be applied to the soil and absorbed by the tree has obvious advantages. Such a preparation, Di-Syston, was obtained in granular form and was applied through the soil with a minimum of labor.

The average number of adult aphids on 10 leaves per tree per season for the two methods of application was:

	Oz. of 5% Di-Syston per tree		
Method of application	5	10	15
(a) in soil in holes spaced around periphery of tree	2262	1976	1389
(b) in soil buried in a trench surrounding the trunk	1927	1895	910

There were no significant differences between the two methods of applying the insecticide. Since method (a) involves a considerably higher labor cost than method (b), the latter is preferred.

The average number of adult aphids on 10 leaves per tree per season was:

			Oz. of 5% Di-Syston per tree			% control determined by Abbott's formula
Area treated	Year treated	Untreated	5	10	15	at 15 oz.
Block I	1959	1220	843	989	719	41
	1960	3552	2335	2067	1502	58
Block II	1960	4634	2095	1936	1150	75

Any two means not underscored by the same line are significantly different at the 5 per cent level.

Although the lower rates of application did not reduce the numbers of aphids significantly in the experiment on Block I in either 1959 or 1960, the highest rate of 15 oz. per

[2] Chemagro Corp., Kansas City, Missouri. 0,0-Diethyl S-2-(ethylthio) ethyl phosphorodithicate.

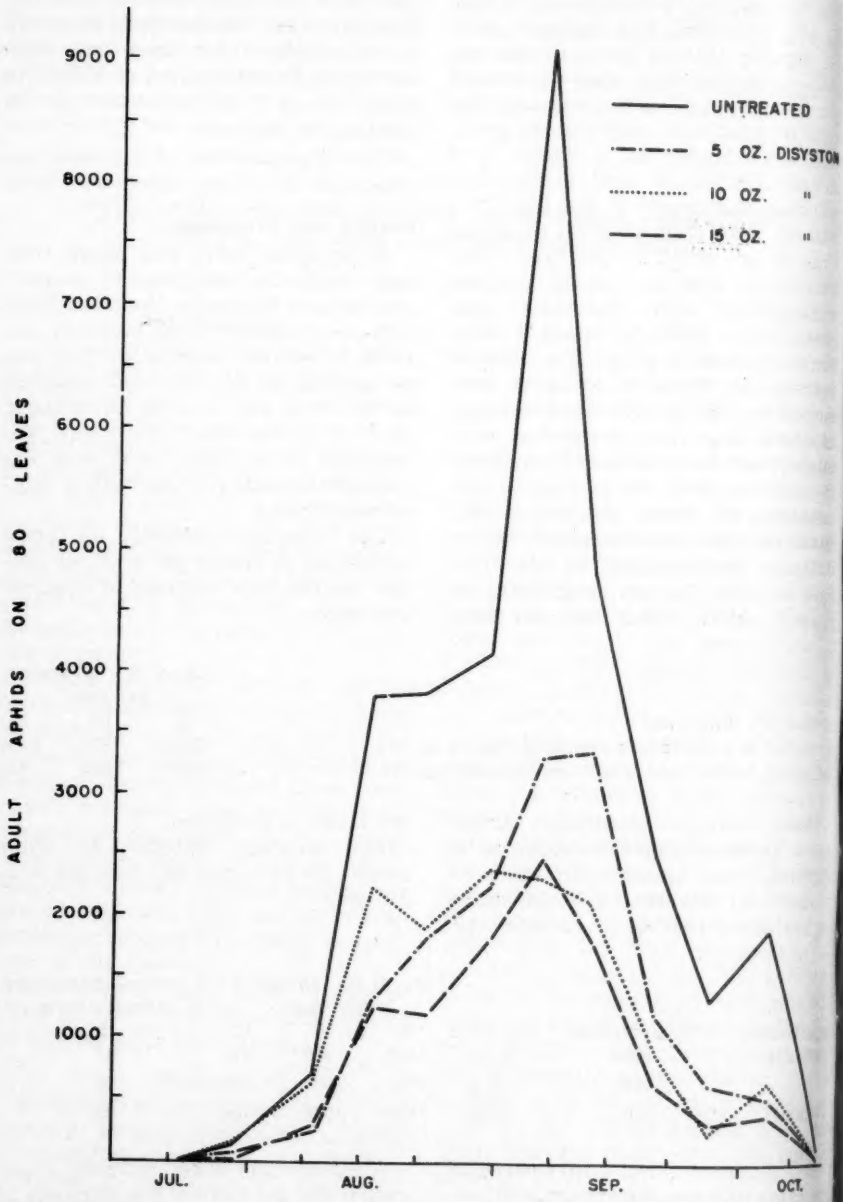

Fig. 1.—Number of adult aphids on ten leaves per tree in Blocks I and II at Vancouver, B.C., 1960.

tree did reduce the numbers significantly below that of the checks. In Block II there was no significant difference between the three levels of application but all significantly reduced the numbers below that on the untreated trees.

Adult aphids on ten leaves per tree in Blocks I and II in 1960, are shown graphically in figure 1. In late July, two months after the insecticide was applied, the populations rose sharply, but the increase in the untreated trees was much more rapid than in the treated trees.

Although the tree trunks ranged from 25 to 41 inches in circumference, the degree of aphid control was not influenced by tree size. However, trees over 40 inches in circumference should probably receive not less than 24 oz. of 5 per cent Di-Syston.

Two trees in Block I, the aphid counts from which were excluded from the experiment, had been treated for three consecutive years with 24 ounces of Di-Syston. They were virtually free from aphids. Indeed they were the only trees under which cars could be parked with impunity.

Summary

Myzocallis walshii Monell is a major nuisance on the red oak, *Quercus borealis* Michx. f. (*Q. rubra* auth.), a boulevard tree of many streets in Vancouver, British Columbia.

The aphid has no alternate host. The males are winged. Mating takes place on the leaves, after which the apterous oviparae move to the vicinity of the main crotch to lay their eggs in crevices of the rough bark. In 1961, the eggs hatched in the middle of May.

A five per cent granular formulation of Di-Syston appreciably reduced the numbers of aphids when applied in the soil around the trees at the rate of 15 oz. per tree.

Acknowledgements

I am indebted to Dr. W. R. Richards, Entomology Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, for identification of the aphid, and to my colleagues Dr. H. R. MacCarthy, Mr. A. R. Forbes, and Mr. M. D. Noble for assistance during the course of this work.

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Heliothis phloxiphaga G. & R. (Lepidoptera: Phalaenidae) on Vancouver Island

In the past twelve years I have met with this species only once, in 1957, when it was frequently to be seen on the open grassy slopes of the hillsides near Victoria and Goldstream.

It was observed in two periods, May 4 to 7, and again from July 5 to August 4. In the first period it was fairly common, feeding on the flowers either of sea blush, **Valerianella congesta**, or of several species of **Trifolium**. More commonly, it was aroused to flight on my close approach, and remaining just out of reach of the net, would fly swiftly and erratically for a short distance and then dive suddenly into the herbage, repeating the process if again disturbed.

In the second period it was not so often seen but several were taken at light. Most of the individuals were obviously second brood, judging from the fresh condition of their wings.

Jones records the species from Victoria, Mill Bay, and Duncan on Vancouver Island so there is evidently a resident nucleus which gives rise to noticeable numbers in an exceptionally favourable season.

H. phloxiphaga is closely related to **H. obsoleta**, a pest associated with the cotton crop of the southern states. I have no information concerning its economic status in British Columbia.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

COMPARISON OF SPRAY DEPOSITS FROM CONCENTRATE AND SEMI-CONCENTRATE ORCHARD SPRAYING[1]

K. WILLIAMS AND A. D. MCMECHAN[2]

Introduction

Although concentrate spray machines are widely used in the Okanagan Valley of British Columbia, some growers use semi-concentrate spray machines. Marshall (2) has defined a concentrate sprayer as one that causes no drip from mature trees sprayed with up to 75 Imperial gallons of spray liquid per acre, and a semi-concentrate sprayer as one that applies 150 to 300 gallons per acre. The experiment reported here was undertaken to compare spray deposits on foliage when sprays were applied at rates of 50, 100 and 250 gallons per acre, with the same amount of spray chemical per acre in each case.

Methods

Two orchard sprayers in common use in the Okanagan Valley were used for the experiment. Sprayer A was a double side sprayer that delivered to each side an airstream with an average velocity, at the vent, of 87 miles per hour, and a volume of 10,300 cubic feet per minute. Sprayer B was a double side sprayer that delivered to each side an airstream with an average velocity, at the vent, of 105 miles per hour and a volume of 7,700 cubic feet per minute. The speed of travel for all spray applications was one mile per hour.

The experiment was conducted in an orchard of mature McIntosh apple trees in which the rows were 30 feet apart and the trees 30 feet apart in the rows. Trees ranged in height from 18 to 22 feet, and in diameter from 25 to 30 feet. In 1959, each sprayer was used to apply Sevin, 50 per cent wettable powder, at the rate of 4 pounds per acre in all treatments. Each treatment consisted of two replicates and there were three treatments per sprayer: 50, 100 and 250 gallons of spray liquid applied per acre. The experiment was repeated in 1960.

Sampling technique and sample treatment were as reported by McMechan et al. (1). Sevin was determined by a colorimetric method (3).

Results and Discussion

The results (Table 1) show that when the same amount of spray chemical was applied per acre the spray deposits on the leaves were not increased by increasing the volume of spray liquid. With both sprayers the 50-gallon-per-acre rate gave equal or slightly higher deposits than the 100- and 250-gallon-per-acre rates.

During the last several years sprays applied at the rate of 50 gallons of spray liquid per acre have given excellent pest control both in experimental plots and grower-sprayed orchards. In limited experiments Fisher and McMechan (unpublished results) have found that chemical thinning of apples was as good with 50 as with 100 or 250 gallons of spray liquid per acre. From the results obtained it appears that there is no advantage in using more than 50 gallons of spray liquid per acre because time is wasted in filling the sprayer when higher volumes are used.

The amount of spray chemical applied per acre should be the same for sprayers applying from 50 to 250 gallons of spray liquid per acre. When applying more than 250 gallons of spray liquid per acre the amount of spray chemical applied per acre may have to be increased because of in-

[1] Contribution No. 72 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Chemist and Agricultural Engineer respectively.

TABLE 1—Mean Spray Deposits of Sevin (mmg./cm.²) on Apple Foliage from Two Sprayers Applying Three Volumes of Spray Liquid per Acre (Sevin, 50 per cent Wettable Powder, Applied at Rate of 4 Pounds per Acre in All Plots).

			Tree-top deposit			Tree-bottom deposit		
			Gallons of Spray liquid per acre			Gallons of Spray liquid per acre		
Sprayer	Year	Replicate	50	100	250	50	100	250
A	1959	1	1.2	0.9	0.6	3.2	2.7	1.9
		2	1.5	1.1	1.0	3.3	3.2	2.1
	1960	1	1.0	1.3	1.1	3.3	3.5	2.4
		2	1.2	0.9	1.1	3.5	2.8	2.5
	Average		1.2	1.1	1.0	3.3	3.1	2.2
B	1959	1	1.5	1.6	1.2	2.5	3.3	2.4
		2	1.6	1.0	1.4	3.0	2.7	2.7
	1960	1	1.4	0.8	1.0	2.8	2.9	2.9
		2	1.2	1.3	1.2	3.7	3.3	3.0
	Average		1.4	1.2	1.2	3.0	3.1	2.8

creased "run-off" of spray liquid from the fruit and foliage.

Summary

When the same amount of pesticide was applied per acre, spray deposits on foliage were equal for two sprayers applying concentrate sprays of 50 gallons of spray liquid per acre and semi-concentrate sprays of 250 gallons per acre.

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Dock sawfly larvae boring holes in cedar siding.

On October 27, 1959, at the request of a pest control operator, I visited a house in Burnaby to investigate a complaint of insects boring into cedar siding. The house was six months old, in a new subdivision on a northern slope with bush only a block away. No landscaping had been done.

Thirteen sawfly larvae were collected on the outside north wall and on a cement walk next to the house. The larvae had moved from the soil, across the walk and up the cement house foundation to the painted cedar siding in order to pupate within holes on the wood. The lower edge of the siding was 18 inches above the concrete walk. By the time the owner enlisted the services of the pest control operator, they had already made many holes in the lowest 18 inches of wood.

The larvae were placed in a jar containing a large cork into which they immediately started to bore. The jar was left in an outdoor screened insectary for the winter. Adult sawflies emerged at the end of May and were identified as **Ametastegia glabrata** (Fallen) by Dr. H. E. Milliron, Entomology Research Institute, Ottawa.

A. glabrata, which feeds on docks (**Rumex** spp.) and **Polygonum** spp., normally hibernates in the stems of these plants. Occasionally it causes considerable damage in the fall by boring into apples in orchards that are not clean cultivated. It may also hibernate in the dead portions of spur growths that have been cut back the previous season.

Becker and Sweetman recorded leaf-feeding sawfly larvae **Macremphytus tarsatus** (Say) in large numbers crawling about dooryards and on buildings in Massachusetts. The larvae bored into wooden structures to make pupal cells, completely embedding themselves in decayed or naturally soft wood.

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Becker, W. B. and H. L. Sweetman. 1946. Leaf-feeding sawfly larvae burrowing in structural wood. J. Econ. Ent. 39: 408.

—*Peter Zuk, Research Station, Vancouver, B.C.*

EXPERIMENTS IN BRITISH COLUMBIA WITH ACRICID, A NEW DINITRO MITICIDE[1]

R. S. DOWNING[2]

The control of phytophagous mites, especially the European red mite, *Panonychus ulmi* Koch, and the McDaniel spider mite, *Tetranychus mcdanieli* McG., is becoming an increasingly important and difficult problem, mainly because of the mites' ability to develop resistance to most acaricides in a relatively short time. In some areas of British Columbia, the European red mite has developed strains resistant to malathion, parathion, and other organic phosphates; to the sulpho-esters fenson, ovex, and Tedion; and in some instances to the chlorinated hydrocarbon Kelthane. The McDaniel spider mite poses a perplexing problem because malathion, parathion, and other phosphates, and in many cases, Kelthane, have been ineffective against it. There are few effective and safe miticides available, consequently, the search for new miticides of different molecular structure has special significance in the research work at Summerland and elsewhere.

Dinitrophenol derivatives have been used extensively for mite control in various areas of the world, especially in British Columbia (5) and, to the author's knowledge, these compounds have yet to induce resistance in insects or mites. Twelve to fifteen years ago dinitro-*o*-cyclohexylphenol (DNOCHP) was used quite extensively in British Columbia but was dropped in favor of newer and less phytotoxic miticides. The fungicide - acaricide Karathane (dinitro capryl phenyl crotonate) is fairly effective against mites (1) but because of its relatively high cost has had very limited use strictly as a miticide. A new dinitro compound, closely related to Karathane, became available for experimental purposes in 1959. This compound, described chemically as 1,1-dimethyl acrylic acid ester of 4,6-dinitro-2-*sec.* butylphenol and given the trade name Acricid, was developed by Farbwerke Hoechst A.G. in Germany. Emmel and Czech (2) state that the mammalian toxicity of Acricid is average, the acute LD50 to rats being 165 mg. per kg. When fed to rats at 200 p.p.m. for 90 days, it caused no harmful effects.

This is a report of laboratory and orchard experiments with Acricid in British Columbia.

Methods

Laboratory Experiments

Stringless green pod beans were grown in four-inch pots, three plants per pot, and only the two primary leaves were allowed to develop. The plants were infested with the McDaniel spider mite, *Tetranychus mcdanieli* McG., or the two-spotted spider mite, *Tetranychus telarius* (L.), by placing on the plants pieces of infested leaves from a stock culture of the mites. The infested plants were placed in a 70°F. greenhouse for four to five days. Then they were sprayed with a compressed air paint gun sprayer until thoroughly wetted. Living and dead mites were counted with a stereomicroscope at intervals after spraying.

Orchard Experiments

Sprays were applied either by a high-volume hand-gun sprayer, or by a concentrate sprayer. The former was operated at 425 p.s.i. and the trees were sprayed until dripping. The latter was a 1955 model "Turbo-Mist" concentrate machine. It applied 50 gallons of spray mixture per acre.

Estimates of mite populations were

[1] Contribution No. 76 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Entomologist.

made by taking a 20-leaf sample from one quadrant of each of five trees per plot. The leaves were processed by the method of Henderson and McBurnie (3) as modified by Morgan *et al.* (4).

Results and Discussion

Laboratory Experiments

On June 4, 1959 Acricid was compared with DNOCHP (DN Dry Mix No. 1, Dow Chemical Company, Midland, Michigan) against the McDaniel spider mite. Three pots of bean plants were used per treatment; mite counts were made four, eight, and twelve days after spraying. Both preparations, at 0.0125, 0.025 or at 0.050 per cent concentration of active ingredient, caused 100 per cent mortality of mites but the Acricid seemed to be somewhat more rapid in its effect.

Lower concentrations were compared against the active stages of the McDaniel spider mite and the results are summarized in Table 1. Acricid at 0.0125 and 0.0062 and DNOCHP at 0.0125 per cent concentration were equal in effectiveness but the two lowest concentrations of DNOCHP gave practically no control of the mite.

TABLE 1.—Average Per Cent Mortality of the McDaniel Spider Mite at Various Periods after Spraying

Miticide	Per cent active ingredient	Average per cent mortality Days after spraying 3	7	12	16
Acricid	0.0125	88	64	78	53
Acricid	0.0062	52	75	73	48
Acricid	0.0031	62	40	29	31
DNOCHP	0.0125	73	70	74	33
DNOCHP	0.0062	38	42	32	30
DNOCHP	0.0031	36	33	28	25
Check—no treatment		12	21	11	16
S.S.R. @ 5% level		31.66	20.80	26.06	16.28
@ 1% level		43.38	28.50	35.71	22.31

Because of their close chemical relationship, Acricid was compared with Karathane (Rohm & Haas Company, Philadelphia, Pa.) in January 1961 against the two-spotted spider mite on bean plants. Table 2 shows that Acricid is considerably more effective than Karathane against the two-spotted spider mite.

TABLE 2.—Average Per Cent Mortality of the Two-Spotted Spider Mite at Various Periods after Spraying

Miticide	Per cent active ingredient	Average per cent mortality Days after spraying 4	9	14
Acricid	0.0125	100	100	100
Acricid	0.0062	100	100	98
Acricid	0.0031	82	100	100
Karathane	0.0125	31	74	82
Karathane	0.0062	22	50	82
Karathane	0.0031	17	8	27
Check—no treatment		16	33	15
S.S.R @ 5% level		21.27	11.93	9.75
@ 1% level		29.15	16.34	13.36

Orchard Experiments

In the first orchard experiment with Acricid, its toxicity to Anjou pear, a variety very sensitive to spray injury, was compared with that of DNOCHP. Acricid 25 per cent wettable powder was applied at two, four, and eight pounds per 100 gallons, and DNOCHP, 40 per cent wettable powder at one, two, and four pounds in the summer with a bucket-pump sprayer. Injury (yellow mottling and browning of the leaves) was evident with DNOCHP even at one pound concentration. On the other hand, Acricid at two pounds caused no injury. At four pounds it produced some yellow mottling and slight necrosis of the foliage. At eight pounds mottling was similar but the necrotic spotting was more obvious.

In the summer of 1959 two orchard experiments were carried out against the European red mite. The first was on mite-infested prune trees to which the spray chemicals were applied by hand-gun sprayer. Acricid, 25 per cent, one pound per 100 gallons gave good control; but one-half pound per 100 gallons was unsatisfactory (Table 3). DNOCHP appeared to be somewhat more effective.

TABLE 3.—Average Numbers of the European Red Mite per Leaf After Spraying Prune Trees by Hand-Gun Sprayer on August 17, 1959

Miticide	Amount per 100 gal.	Average number mites per leaf Before spraying Aug. 17	After spraying Aug. 24	After spraying Sept. 1
Acricid (25% w.p.)	1 lb.	31.5	0.2	0.2
Acricid (25% w.p.)	8 oz.	40.7	10.7	4.3
DNOCHP (40% w.p.)	5 oz.	34.9	0.3	0.3
Check—no treatment	—	54.1	28.0	0.6

For the second comparison, the two preparations were applied by concentrate sprayer to Newtown apple trees infested with the European red mite. One week after spraying, Acricid applied at eight pounds per acre had reduced the mites from 11.5 to 0.7 per leaf. DNOCHP at three pounds per acre had reduced them from 16.0 to 2.0 per leaf. DNOCHP caused slight injury to Newtown apple foliage.

In 1960 Acricid was applied against the European red mite infesting Jonathan apple trees in the pink bud stage. It was compared with Karathane, 25 per cent wettable powder, and fenson (50 per cent *p*-chlorophenyl benzene sulphonate, Murphy Chemical Company, Wheathampstead, England), a currently recommended "pink-bud" miticide. The preparations were applied with a concentrate sprayer. Seventy-nine days later the average numbers of mites per leaf were:

Miticide	Pounds per acre	Average numbers mites per leaf
Fenson 50%	4	0.1
Acricid 25%	8	1.5
Karathane 25%	6	16.4
Check—no treatment		10.5

Acricid was compared with Kelthane [18.5 per cent bis (*p*-chlorophenyl) trichloroethanol, Rohm & Haas Company, Philadelphia, Pa.] in June 1960 against the European red mite on seedling apple trees. The results of these hand-gun applications are given in Table 4. Acricid at three-quarters or one pound per 100 gallons gave good control as did Kelthane.

TABLE 4.—Average Numbers of the European Red Mite per Leaf after Spraying Apple Trees by Hand-Gun Sprayer on June 28, 1960

Miticide	Amount per 100 gal.	Average number mites per leaf* Before spraying June 27	After spraying July 5	July 12	July 20	July 26
Acricid (25% w.p.)	0.75 lb.	7.4	0.7	0.3	0.4	0.6
Kelthane (18.5% w.p.)	2.00 lb.	4.4	0.0	1.3	0.3	0.2
Check—no treatment		17.6	38.8	34.0**	0.2	2.8

* Based on 50 leaves per plot

** Sprayed with Acricid (25% w.p.) 1 lb. per 100 gal. on July 13, 1960

Kelthane and Acricid were compared again against the European red mite in July, application being by concentrate sprayer to Delicious, Winesap, Jonathan, Newtown, and Stayman apple trees. As indicated in Table 5 both miticides controlled the mite well. Neither preparation caused any foliage or fruit injury.

TABLE 5.—Average Numbers of the European Red Mite per Leaf after Spraying Apple Trees by Concentrate Sprayer on July 26, 1960

Miticide	Amount per acre	Average number mites per leaf Before spraying July 25	After spraying Aug. 2	Aug. 9	Aug. 16	Aug. 29
Acricid (25% w.p.)	8 lb.	17.2	0.6	5.2	1.7	2.3
Kelthane (18.5% w.p.)	10 lb.	13.3	0.4	4.6	1.8	0.6
Check—no treatment	—	6.6	3.9	9.8	11.0	3.8

Summary

Acricid, a new dinitro miticide of moderate toxicity to mammals, was less toxic to pear and apple trees than the older and more hazardous dinitro miticide, DNOCHP. In laboratory experiments against the McDaniel spider mite, Acricid was somewhat more effective than DNOCHP. Against the two-spotted spider mite, it was more effective than a third dinitro preparation, Karathane. In field experiments against the European red mite, Acricid was effective at one pound per 100 gallons in high-volume application and at eight pounds per acre in concentrate spraying, but was not quite as effective as DNOCHP.

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SOME HETEROPTERA NEW TO BRITISH COLUMBIA

G. G. E. SCUDDER[1]

During the course of the past three years, collecting in British Columbia and examination of existing collections have produced a number of Heteroptera not recorded from the Province. Whilst a revised annotated check-list of Heteroptera for British Columbia is in preparation, it is evident that it will be some time before this is complete; it seems worthwhile to record now some of the more interesting new records.

Family PENTATOMIDAE

Sciocoris microphthalmus Flor. Bouchie Lake, near Quesnel, 31. vii. 1959 (G. G. E. Scudder); Wycliffe, 8. vi. 1961 (G. G. E. S.); Cranbrook, 8. vi. 1961 (G. G. E. S.); Sullivan River, Big Bend Highway, 10. vi. 1961 (G. G. E. S.)—abundant on flower heads of Yellow Dryas (*Dryas drummondii* Rich.); Westwick Lake, Cariboo, 23. vi. 1961 (G. G. E. S.).

Family LYGAEIDAE

Arphnus coriacipennis (Stal.). Vancouver, 21. ix. 1921 (W. Downes); Penticton, 22. ix. 1921 (W. D.); near Olalla, 6. viii. 1959 (G. G. E. S.); Vaseux Lake, 4. vi. 1961 (G. G. E. S.). Ashlock (1961) has recently synonymised *A. tristis* Van Duzee and *A. profectus* Van Duzee under *A. coriacipennis*. He indicates that there appear to be three colour forms of *coriacipennis*, ones with head and pronotum black (*=A. tristis*), ones with head and thorax brownish (*=A. coriacipennis s. str.*) and ones which are quite pale (*=A. profectus*). At the moment it is not possible to state what causes these colour variations. The specimens from Vancouver, Vaseux Lake and near Olalla are dark forms and those from Penticton are pale. Ashlock records *A. coriacipennis* from California, Oregon, Washington, Nevada, Utah and New Mexico: Utah specimens have been taken on *Juncus balticus*.

Kolenetrus plenus (Distant). Westwick Lake, Cariboo, 1. viii. 1959 (G. G. E. S.), a single brachypterous male. This species was originally described from Guatemala and Bueno (1946) records it from Massachusetts, Connecticut, New York and Arizona: Moore (1950) records it from Quebec. The Westwick Lake specimen was taken by searching among *Juncus* tufts at the edge of the lake. When first captured, I mistook the specimen for an *Acompus*, not only due to its appearance, but also because this is a frequent habitat for *Acompus* in Britain. However, dissection revealed that spiracles on abdominal segments II, III and IV were dorsal indicating that the specimen belonged to the Myodochini; further study indicated that it belongs to the genus *Kolenetrus*. It seems to be conspecific with *K. plenus* (Dist.); this latter species has the fore femora markedly incrassate and with two spines.

Since I at first thought the specimen to be an *Acompus*, I considered that others also might have made the same mistake and that perhaps the record of *Acompus* from British Columbia might really refer to *Kolenetrus*. Barber (1918) recorded *Acompus rufipes* (Wolff) from British Columbia. His record was based on two specimens in the United States National Museum. These were from the collection of P. R. Uhler and one had the data 'Victoria' and the other 'N.R.R.', which Barber (loc. cit.) considered to refer to Northern Pacific or Canadian Pacific of British Columbia.

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Through the kindness of Dr. D. M. Weisman and Dr. Gates Clarke of the United States National Museum, I have been able to borrow and examine the specimen from 'Victoria' mentioned by Barber: Dr. Weisman *(in litt.)* informs me that he is unable to trace the other specimen in the Museum collections.

Examination of the 'Victoria' specimen, a female, shows that this is not *Acompus rufipes* and belongs neither to the genus *Acompus* Fieber nor to the genus *Kolenetrus* Barber. It is in fact a representative of a new Australian genus of which I have seen a number of specimens from New South Wales. Thus I think it is safe to conclude that the 'Victoria' specimen is from Victoria, Australia and not from British Columbia, Canada. *Acompus rufipes* is therefore here removed from the list of Heteroptera from B.C.

Ligyrocoris latimarginatus Barber. Goldstream, 15. ix. 1927 (W. D.). A Pacific coast species recorded from California, Oregon and Washington.

Megalonotus chiragra (Fab.). I have already noted (Scudder, 1960) that this species occurs in British Columbia, but have given no details. Specimens examined are as follows: Duncan, 1. x. 1932 (W. D.); Wellington, 14. iv. 1949 (R. Guppy); Salt Spring Is., 25. vi. 1949 (G. J. Spencer) —on strawberries; University Campus, Vancouver, 14. viii. 1958, 22. ix. 1958, 18. iv. 1959 (G. G. E. S.); Vernon, 5. viii. 1959 (G. G. E. S.); Cultus Lake, 9. v. 1959 (G. G. E. S.); White Rock, 7. iii. 1960 (G. G. E. S.); West Vancouver, 18. v. 1961 (G. J. S.); Creston, 7. vi. 1961 (G. G. E. S.); Sicamous, 11. vi. 1961 (G. G. E. S.); Pavilion, 30. vi. 1961 (G. G. E. S.); Essondale, 25. v. 1961, 1. vi. 1961 (W. Lazorko). I have also seen specimens in the Canadian National Collection from Victoria (G. S. Walley), Mission City (W. R. M. Mason) and Oliver (J. R. McGillis), and specimens are at hand from Seattle, Wash. In Vancouver and on the University Campus, *M. chiragra* in 1959 was very abundant on boulevards. It is possible that this species was introduced into the area in ballast (see Lindroth, 1957: Scudder, 1958): I was in error (Scudder, 1960) in stating that Slater & Sweet (1958) suggested that this was the mode of introduction of *M. chiragra* in the Eastern United States.

Most of the British Columbia material seems to be referable to *M. chiragra sabulicola* (Thoms.) and further to the nominate form of this with both the second and the third antennal segments usually pale in the basal half; for other notes on this complex see Bueno (1946). We may note here that there does not appear to be a significant difference in the dimensions of the scutellum in the various Nearctic and Palaearctic populations, when the difference in wing development and consequent thoracic changes, are taken into account. Measurements made are listed, the ratio scutellum length/scutellum width being given with the standard error of the mean: *chiragra chiragra* from Southern England ♂ 1.28 ± 2.49, ♀ 1.27 ± 2.65; *chiragra sabulicola* from Jersey, Channel Islands ♂ 1.29 ± 3.23, ♀ 1.40 (only 1 specimen studied); *chiragra* from Vancouver, B.C. ♂ 1.28 ± 3.46, ♀ 1.32 ± 1.72.

Stygnocoris pedestris (Fallén). Malahat, 20. ix. 1950 (W. D.); Cultus Lake, 2. ix. 1959 (G. G. E. S.); Lions Bay, Squamish Road, 16. x. 1960 (G. J. S.). This species was first recorded in North America by Barber (1918) from specimens taken in Nova Scotia and New York. It is recorded from Quebec by Moore (1950).

Family TINGIDAE

Gargaphia opacula Uhler. Dog Lake (Skaha Lake), 29. viii. 1946 (W. D.); Vaseux Lake, 4. vi. 1961 (G. G. E. S.); 8 mi. N. of Oliver, 18. v. 1958 (H. & A. Howden) (Can. Nat. Coll.). Also taken

by the late W. Downes on *Purshia tridentata* D.C. at Oroville, Wash., 1. vii. 1927.

Teleonemia nigrina Champ. Agassiz, 16. vii. 1933, 23. vii 1933 (W.D.). According to notes left by the late W. Downes, these specimens were taken on *Penstemon menziesii* Hook at 1,000 ft. and on *P. ruficola* and *P. diffusus* Dougl. in rock gardens.

Melanorhopala clavata Stal. Boitano Lake, Cariboo, 30. vii. 1959 (G. G. E. S.); Westwick Lake, Cariboo, 23. vi. 1961 (G. G. E. S.).

Dictyla labeculata (Uhler). Cache Creek, 18. vi. 1959 (G. G. E. S.). This species, formerly listed in the literature as *Monanthia labeculata* Uhler, now must be placed in the genus *Dictyla* Stal. since it has been shown that *Monanthia* Le Peletier is a synonym of *Copium* Thunberg (see Drake & Ruhoff, 1960).

Family REDUVIIDAE

Reduvius personatus (L.). Creston, vii. 1949; Oliver, 26. v. 1945 (D. Blair); Oliver, 9. vii. 1961 (A. T. S. Wilkinson); Vaseux Lake, 12. vi. 1961 (P. Zuk); Vancouver, 19. x. 1960 (P. Z.)—the latter taken as fourth and fifth instar larvae and reared. These insects were fairly abundant in a dockside warehouse in Vancouver.

Family CIMICIDAE

Hesperocimex coloradensis List. (det. R. L. Usinger). Summerland, 16. vii. 1949 (G. B. Rich)—from nest of Red-shafted Flicker *(Colaptes cafer* (Gmelin)). Lattin & Schuh (1959) recorded this rare species from Oregon and note that previous records are from Colorado, Nebraska, California and Mexico. The Oregon material was taken from an abandoned woodpecker nest and the species is usually associated with the Purple Martin *(Progne subis* (L.)). I wish to thank Prof. G. J. Spencer for allowing me to include this record.

Family NABIDAE

Stalia major (Costa). University of B.C. campus, Vancouver, 20. x. 1949 (Orchard); Brighouse, 15. x. 1944 (I. Kosin). Possibly introduced in ballast.

Family MIRIDAE

Pronotocrepis clavicornis Kngt. Rock Creek, 30. v. 1958 (Forest Insect Survey, Vernon)—on *Ribes* sp. Described originally from specimens taken at Ft. Garland, Colorado.

Dichrooscytus suspectus Reuter. Elko, Twin Lakes, viii (F. I. S. V.); Soda Creek, vii (H. R. MacCarthy); Otterhead River, viii (F. I. S.:V); Vanderhoof, vii (F. I. S.:V) — on *Picea;* Topley, vii (F. I. S.:V)—on White Spruce *(Picea glauca).*

Deraeocapsus fraternus (Van Duzee). Revelstoke, 17. vii. 1925 (A. A. Dennys); 4 miles N. of Moyie, 28. viii. 1942 (F. Hesketh); Garibaldi, 13. vii. 1951 (W. Cottle); Salmo, vi (F. I. S.:V); Christina Lake, vi (F. I. S.:V). The species was described from the Sierra Nevada, near Lake Tahoe, California.

Orectoderus obliquus Uhler. Jesmond, Williams Lake, Canim Lake: specimens in Canadian National Collection, Ottawa.

Family SALDIDAE

Lampracanthia crassicornis (Uhler). Colpitt Lake, Cariboo, 17. vi. 1959 (G. G. E. S.); Westwick Lake, Cariboo, 1. viii. 1959 (G. G. E. S.); Boitano Lake, Cariboo, 17. vi. 1961 (G.G.E.S.).

Micracanthia ripula Drake. Kamloops (G. J. S.); Marble Canyon, Lillooet, v. (J. McDunnough) (Can. Nat. Coll.).

Family HYDROMETRIDAE

Hydrometra martini Kirk. Lytton, 24. vii. 1931, 26. vii. 1931 (G. J. S.).

Family VELIIDAE

Microvelia buenoi Drake. Elk Lake, Saanich Distr., 9. iv. 1926 (W. D.);

Duncan, 4. ix. 1926 (W. D.); Chilcotin, 26. v. 1959 (G. G. E. S.); Oliver, 5. vi. 1961 (G. G. E. S.); Westwick Lake, Cariboo, 14. vi. 1961 G. G. E. S.); 149 mile Lake, Cariboo, 22. vi. 1961 (G. G. E. S.); Williams Lake District, 24. vi. 1961 (G. G. E. S.); found in ponds and sloughs often in association with Duckweed *(Lemna)*.

Microvelia pulchella Westw. Oliver, 6. ix. 1957 (W. D.); Vaseux Lake, 13. viii. 1957 (W. D.); in sheltered waters at edge of lake, behind bulrushes.

Family HEBRIDAE

Merragata hebroides White. Oliver, 15. viii. 1957 (W. D.).

Family CORIXIDAE

Dasycorixa rawsoni Hungerford. (det. I. Lansbury). McIntyre Lake, Chilcotin, 20. x. 1960 (G. G. E. S.)—taken in association with the corixids *Cenocorixa bifida* (Hungerford) and *Hesperocorixa laevigata* (Uhler), the notonectids *Notonecta kirbyi* Hungerford and *N. undulata* (Say) and the dytiscids *Dytiscus ooligbuki* Kby. and *D. cordieri* Aube. *D. rawsoni* was not recorded from the Province by Lansbury (1960) and previously has been recorded only from Southern Saskatchewan (Hungerford, 1948).

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ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART X—NOTODONTIDAE[1]

D. A. ROSS[2] AND D. EVANS[3]

The larvae of this family feed exclusively on broad-leaved hosts, chiefly of Salicaceae and Betulaceae. Several species are commonly found on members of Rosaceae as well. *Datana ministra* and *Schizura concinna* occasionally have been sufficiently numerous to cause noteworthy defoliation.

Notodontid larvae are quite similar to the cutworms, Noctuidae, but usually have more elongate heads. The majority are strikingly marked; most species have prominences. Setae on the upper body are primary, excepting *Datana* and *Ichthyura* which have a light clothing of fine secondary hairs. There are ventral prolegs on A3-6; and the anal prolegs are more or less reduced or modified. The anal prolegs may be held up at rest, and are not used by *Schizura* or *Cerura* for locomotion. The eversible gland on the prothoracic venter is branched on some species. Most notodontids overwinter as larvae in cocoons.

Ichthyura apicalis Walker. *Populus tremuloides* (1). Mile 50 Big Bend Highway. LARVA: head brown, excepting unpigmented configuration about the frons; no swellings apparent; pronotal shield with pair of brown patches; body drab cream-brown; faint dorsal lines. Head and body moderately clothed with fine short white hairs.

Ichthyura strigosa Grote. *Populus tremuloides* (1). Wasa. LARVA: unknown to writers.

Ichthyura albosigma Fitch. *Populus tremuloides* (4), *Salix* sp. (1), *Alnus* sp. (1). Squilax, Kersley, Marguerite, Prince George, and southern V.I. One from Mile 49 Dawson Rd., Y.T. LARVA: young instars prominently humped, pale green with fine red lines and abdominal segments 1, 3, and 8 also red. Late instars stippled mauve-grey and brown, with indistinct brown lines pale edged; large black spiracles; shallow yellow tubercles, long silvery setae; the head large and mottled.

Ichthyura brucei Hy. Ed. *Populus tremuloides, Salix* sp. (1). Central Interior. LARVA: head black, excepting unpigmented inverted Y above and bordering frons; small transverse swellings on dorsum of A1 and 8, lateral portions of prothoracic shield, small supraspiracular patches, and spiracles, black. Head and body lightly clothed with fine, moderately long, white hairs.

Datana ministra Dru. Yellow-necked caterpillar. *Betula* spp., *Amelanchier* sp., *Crataegus* spp., *Prunus* sp. (1), *Salix* sp. (1). Central portion Southern Interior. LARVA: 1¾ inches; head and body black (body reddish-brown in earlier instars); prothoracic shield yellowish-brown; yellow subdorsal, supraspiracular, subspiracular, subventral and ventral lines; body sparsely clothed with long grey hairs.

Odontosia elegans Stkr. *Populus tremuloides*, Southern Interior, and Cuisson Creek. LARVA: 1¾ inches; head and thorax reddish to yellowish brown, glossy; dorsum of body mottled brown, venter of abdomen cream;

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brown prothoracic shield; brown shallow transverse ridges on A2 and A8; brown blotch about spiracles down to prolegs on A3-6.

Notodonta simplaria Graef. *Salix* sp. (3), *Populus tremuloides* (1). Golden, Ochiltree, Lardo, and Burns Lake. LARVA: 1½ inches; head tapered to vertex, stippled with black; body purplish, mottled; pale diagonal lines; conical humps on A2, 3 and 8; faint pale subspiracular stripe running down to tip of ventral proleg on A6. Black above bases of thoracic legs; black double dorsal stripe on thorax and on humps of A2 and 3.

Pheosia rimosa Pack. *Salix* spp., *Populus tremuloides, P. trichocarpa, Betula* sp. Interior B.C. LARVA: about 2 inches; green or yellowish-brown, glossy; horn on A8; black transverse band on T2 and A8, may be broken on the former segment; thoracic legs red; spiracles black, pale-ringed.

Pheosia portlandia Hy. Ed. Vancouver Island. LARVA: unknown to writers.

Nadata gibbosa A. & S. *Betula* spp., *Salix* spp., *Alnus* spp., *Quercus garryana, Populus trichocarpa* (1), *Acer circinatum* (1), *Prunus* sp., *Rosa* spp. General throughout B.C. LARVA: 1¾ inches; head and body pale bluish-green, covered with a bloom; body flecked with yellow laterally; subdorsal stripe, base of prolegs and posterior margin of suranal plate, pale yellow; no protuberances; setae minute; spiracles small, reddish-brown.

Dicentria pallida Stkr. Vancouver Island. Hosts and larvae unknown to writers.

Schizura semirufescens Wlk. *Alnus* spp., *Salix* spp., *Betula papyrifera* (3), *Quercus garryana* (1), *Acer circinatum* (1), *Amelanchier* sp. (1). Southern B.C. and V.I. LARVA: 1½ inches; cream and brown head and body; abdomen may be tinged with green; brown M on head, X between arms; hump at posterior margin of metathorax; elongate forked protuberance on A1 bent forward; forked hump on A5 and 8. White V on A6 and 7.

Schizura ipomoeae Doubleday. *Betula papyrifera, Alnus* spp. (3), *Salix* sp., *Amelanchier* sp. (1). Southeastern B.C. (Jones, 1951, also records it from southern V.I.). LARVA: 1½ inches; brown and green with markings on dorsum of abdomen; a pair of black longitudinal lines on each side of the front of the head, with a reddish-brown X between; thorax green, speckled with brown; broken, reddish-brown dorsal stripe with white edge, split on thorax and diverging on T1; pleura on T1 partly brown; white dorsal patches on A1-4, shield-shaped on A2 and 3 and white broad-based V on A6-7; elongate short-forked tubercle on A1; smaller paired tubercles on A5 and 8. The setae on this species are more prominent than on the other three species.

Schizura concinna S. and A. Red-humped caterpillar. *Salix* spp., *Betula* spp., *Prunus* spp., *Populus tremuloides, P. trichocarpa, Alnus* spp., *Acer glabrum* and miscellaneous other broad-leaved hosts. Southeastern B.C. Occasionally known to completely denude single trees or clumps of trees. LARVA: 1½ inches; head and transverse swelling on A1, a dull red; body glossy, dull yellow streaked with black or reddish-brown; subdorsal, supra- and subspiracular stripes white, edged with black; tubercles black, those on dorsum elongated, the longest on A1.

Cerura occidentalis Lintner. *Populus trichocarpa, Salix* spp. Kelowna, Houston, Vernon, Prince George,

B.C., and Carmacks, Y.T. LARVA: body 1½ inches + ¼ inch stemapods; head brown, dark brown bar from ocelli to vertex; body green; dorsal stripe brown-edged with cream, stripe broad at front of T1, tapered to posterior margin of T2, the "abdominal saddle" broadest on A4 where it encompasses the spiracles; brown subventral patches on prolegs of abdominal segments; pair of vestigal subdorsal warts on T1; small slightly bilobed swelling on T2.

Cerura scolopendrina Boisduval. *Salix* spp., *Populus tremuloides*. Southern B.C. and V.I. and two records from Skeena River Valley. LARVA: 1½ inches + 1/3 inch stemapods; head brown, darkest near vertices; body yellow-green; dorsal "stripe" purplish-brown, broad at front of T1, tapered to the posterior margin of T2, slightly interrupted at leading edge of T3. The "abdominal saddle" broadest on A4 where it extends down behind the spiracles; a pair of small subdorsal warts on T1; swelling if present on T2, not bilobed.

Schizura unicornis A. & S. *Alnus* spp., *Betula* spp., *Salix* spp., *Malus* spp., *Prunus* spp. (3), *Amelanchier* sp. (1), *Populus tremuloides*. Southern B.C. and V.I. LARVA: similar to *ipomoeae*. Head light brown with darker brown longitudinal stripes from ocelli to vertices; thorax green, pleura of prothorax partly brown, not joined to dorsal stripe; abdomen light brown and olive green; brown dorsal stripe on thorax, split on prothorax but not diverging; whitish triangular, and truncated triangle-like markings on dorsum of A1-3; narrow-based white dorsal V on A6 and 7; prominent forked tubercle on A1; paired swelling on A5 with vestiges of tubercles; pair of prominent tubercles on prominent swelling on A8.

Gluphisia septentrionis Wlk. *Populus tremuloides, P. trichocarpa*. Vernon, Squilax, 70 Mile House, 83 Mile House, Place Lake, Exchamsiks. LARVA: Head yellow-green with or without black stripe on either side of front; body yellow-green; yellow subdorsal stripe; reddish broken patches on dorsum of thoracic and abdominal segments — excepting A1 and sometimes A2.

The California Tortoise-Shell, **Nymphalis Californica** Bdv., on Vancouver Island

After an apparent absence of eight years this butterfly has again been seen in southern Vancouver Island. It was first noticed on September 8, 1960, and was last seen on October 18. The butterflies frequented highways, sheltered valleys, and slopes, usually flying back and forth, settling occasionally on roads, fences or bushes. While not observed to visit flowers, they sought damp places and over-ripe fruit such as blackberries and apples. A slight tendency to drift eastward was at times indicated but not so noticeably as in 1952.

At least some individuals hibernate here, for one was seen on the warm southern slope of Mount Douglas on January 28, 1961.

Following the immigration of 1952, this butterfly was frequently seen up to April 23, 1953, after which it disappeared. Whether the same pattern will eventuate in 1961 remains to be seen.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

ADDITIONS TO THE LIST OF CICADELLIDAE (HOMOPTERA) OF BRITISH COLUMBIA, WITH ONE GENUS AND FOUR SPECIES NEW TO CANADA

G. G. E. SCUDDER[1]

In his excellent monograph on the Cicadellidae of Canada and Alaska, Beirne (1956) gives the general distribution of the various species including those known to occur in British Columbia. Too little collecting has been done to allow the exact distribution of the British Columbia species to be plotted so an annotated checklist for the family is premature.

However, it seems worthwhile to record the occurrence in the Province of eleven species not previously noted from British Columbia: four of these and one of the genera are not recorded in Canada by Beirne (*loc. cit.*).

Macropsis occidentalis (Van Duzee). Royal Oak, 7. viii. 1919 (W. Downes); Saanich District, 7. vii. 1919 (W.D.): new to Canada. Recorded from California and Nevada by Breakey (1932) and DeLong & Knull (1945). This is a pale yellow-green to brown species with a black spot on the epimera. Breakey (loc. cit.) who revised the Nearctic *Macropsis*, notes that Van Duzee reports this species from *Salix* sp. In Beirne (1956) it would run to the *virescens* and *viridis* couplets. Breakey notes that *occidentalis* is similar to *M. viridis* (Fitch) from which it differs by having the rugae and punctures more coarse, the epimera with a black spot and the length 5mm. or less. *M. occidentalis* has the pronotum parabolically right-angled anteriorly, but lacks the black spot at the base of the hind tibiae, typical of *M. virescens* (Gmel.).

Thatuna gilletti Oman. Erie, 6. vi. 1961 (G. G. E. S.): new to Canada. Originally described from Moscow, Idaho and hitherto known only from that state and Washington. The genus has not been reported in Canada, and thus does not appear in Beirne (1956). It belongs to the tribe Errhomenellini of which to date only *Errhomus montanus* (Baker) is recorded in Canada from the southern part of British Columbia. *Errhomus* Oman can be separated from *Thatuna* Oman by the fact that the former lacks the numerous fine striae on the crown. In *Thatuna*, the head is short and broad and narrower than the pronotum, and the posterior margin of the pronotum is incised. A full description of the genus and species is to be found in Oman (1938).

Colladonus incertus (Gillette & Baker). Royal Oak, 30. viii. 1949 (W.D.); Saanich, 16. viii. 1952 (W.D.); Duncan, 22. ix. 1925 (W.D.): new to Canada. DeLong & Knull (1945) record this species from the following states—Colo., D.C., Fla., Mass., N.J., N.Y., N.C., N.D., Ohio and Tenn. Nielson (1957) has recently revised the genus *Colladonus* and notes that at the time of writing only female specimens of *C. incertus* were known. He remarks that it is at present placed in *Colladonus*, but states that this is presumably because the female has a spatulate process on the seventh sternum. He considered that since males were unknown, *incertus* should be treated as a species *incertae sedis*. All the British Columbia specimens examined are female. In Beirne (1956) *incertus* keys down with *C. flavocapitatus* (Van Duzee). Nielson (1957) states that *incertus* is similar to *C. waldanus* Ball which Beirne includes under *flavocapitatus*. From the latter *incertus* can be distinguished by having the hemielytra with the clavus brown and the corium with an oblique

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brown dash. Although these markings are distinct, they do not fuse to produce a *montanus*-like pattern. One should also note here that *C. egenus* Ball must be added to the British Columbia and Canada list. Nielson (1957) reports this from Utah northwestwardly to British Columbia, the type locality being Chilliwack, B.C. Recently I have come across a specimen of *C. egenus* with the data Penticton, 22. ix. 1919 (W.D.). This specimen, a male, was easily recognised by the unique falcate, serrate pygofer spine and the long bifurcate processes which are more than one-half as long as the aedeagel shaft. Other British Columbia species of *Colladonus* not considered in Beirne (1956) will be found in the paper by Nielson.

Paraphlepsius eburneolus (Osborn & Lathrop). Penticton, 16. viii. 1920 (W.D.). In Canada, previously recorded only in southern Saskatchewan and Manitoba.

Texananus extremus (Ball). Goldstream, 28. iv. 1926. (W.D.): new to Canada. Crowder (1952) reports this species from Utah, Arizona, Oregon, California and Colorado. The genitalic characters are distinctive in the male. *T. extremus* has the process of the connective as a single shaft (distinguishing it from *T. oregonus* [Ball]) and has the aedeagal shaft very short, the apical half not strongly tapering to apex, the inner margin of plate at apex constricted. In comparison, *T. decorus* (Osb. & Ball), *T. marmor* (Sand & DeL.), *T. arctostaphylae* (Ball) and *T. proximus* Crowder have the aedeagal shaft tapering strongly to apex and sickle-shaped, and the inner margin of plate less constricted. *T. extremus* also characteristically has the ventral shaft of the connective tapering to apex from its base in lateral view. This smallish pale species is also here recorded from Idaho. In the Downes collection, now at the University of British Columbia, are specimens taken by the late W. Downes at Boise, Idaho on 25 July, 1923: they were determined by P. W. Oman.

T. decorus (Osborn & Ball). Midday Valley, Merritt, 5. viii. 1925, 25. viii. 1925, 11. ix. 1925 (Wm. Mathers). In Canada, previously recorded only from southern Ontario.

Fieberiella florii (Stal). Penticton, 11. viii. 1957 (W.D.) — on Virginia Creeper. Beirne (1956) notes that this species occurs in southern Ontario and suggests that it was introduced from Europe, since this is a European species. A similar introduction in British Columbia is probable.

Driotura gammaroides (Van Duzee). Riske Creek, Chilcotin, 26. v. 1959, 30. v. 1959 (G.G.E.S.); 149 Mile Lake, Cariboo, 29. v. 1959 (G.G.E.S.): recorded as widely distributed and locally common in the grassland regions of Alberta, Saskatchewan and Manitoba. Dr. J. P. Kramer *(in litt.)* states that in the United States this species extends as far west as Montana.

Athysanella acuticauda Baker. Riske Creek, Chilcotin, 26. v. 1959 (G.G.E.S); Westwick Lake, Cariboo, 14. vi. 1961; (G.G.E.S.); Pavilion, 30. vi. 1961; (G.G.E.S.); Wardner, 7. vi. 1961 (G.G.E.S.); 149 Mile Lake, Cariboo, 15. v. 1959, 22. vi. 1961 (G.G.E.S.): common on open range land. Beirne notes that in Canada it is widely distributed and locally abundant in the grassland regions of Alberta, Saskatchewan and Manitoba, being also found in southern Quebec.

A. robusta (Osborn). Fort St. John, Peace River, 11. vi. 1959 (G.G.E.S.): taken only on dry grassland slopes of the Peace River canyon. In Canada recorded as widely distributed and locally common in the grassland re-

gions of Alberta, Saskatchewan and Manitoba.

A. occidentalis Baker. Hedley, 4. vi. 1961 (G.G.E.S.): recorded from the grassland regions of Alberta and Saskatchewan.

Acknowledgements

The research for this paper was done whilst in receipt of a grant from the National Research Council of Canada. I am indebted to Dr. J. P. Kramer of the United States National Museum for kindly checking and determining the species listed. Material is in the collections at the University of British Columbia.

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BOOK NOTICE

The Cicindelidae of Canada, by J. B. Wallis. University of Toronto Press, Front Campus, University of Toronto, Toronto 5; 100 pages, 6 x 9 inches, 4 colour plates, halftones, maps, $5.00.

The bright colours and fascinating ways of this small but important group of insects attract immediate attention. Cicindelidae, or tiger beetles, are frequently encountered, but they are difficult to capture, since they are alert and elusive, and still more difficult to identify. This intensive study of the distinguishing characteristics, geographical distribution and variation, and habits and habitats of tiger beetles in Canada—the culmination of the author's main interest for many years—will provide a much-needed reference work. Studies of insect families are scarce, and professional and amateur entomologists alike will find this book a most useful aid in their investigations and a stimulus to further research.

J. B. Wallis, one of Canada's most distinguished amateur entomologists, is an honorary member of the Entomological Society of Manitoba and was one of the founders of the Natural History Society of Manitoba, which awarded him its medal for outstanding work in entomology.

The note above was received from the University of Toronto Press in September. We are pleased to draw the attention of our members to this important new Canadian work.

THE IDENTITY OF THE BLACK-WIDOW SPIDER IN BRITISH COLUMBIA

G. J. SPENCER[1]

The genus *Latrodectus* Walckenaer comprises the "Black-Widow" spiders of the United States, though each part of the world where these spiders occur has its own name for them. An abstract of a paper by Levi (1959) as it pertains to the black-widows of this Province, is presented here.

These poisonous spiders are notoriously difficult taxonomically and considerable confusion has arisen from physiological observations on specimens of uncertain determination. All widespread species show variation, and representatives of this genus from neighboring colonies may differ greatly in color or structure. Since the female genitalia and the palpi of the male are required for identification, it is necessary to have large collections of both sexes, especially since the shape of the palpus may be considerably changed after use in transmitting sperm to the female. Immatures cannot be identified with certainty. Fortunately Levi had enormous collections to work over, from large areas of all the continents.

The extreme variation in these spiders is shown by the fact that at least 43 species have been named in the genus; Levi reduces them to six. To illustrate one of the most remarkable characteristics of the genus *Latrodectus,* I shall touch on the very wide and discontinuous occurrence of the six species.

Latrodectus geometricus C. L. Koch is a cosmotropical species reported from the southern United States, especially Florida; the West Indies; Colombia in South America; Saudi Arabia; Kenya, Zanzibar, Madagascar and Capetown; some of the East Indian Islands; Australia; and Spain.

Latrodectus mactans (Fabricius), *The* Black-Widow Spider, is practically world-wide, being reported from the warm areas of all the continents; it has at least 46 synonyms and 5 subspecies and the name *mactans* has been attached to a range of other species. It occurs in warmer parts of the United States but northward only as far as Oregon. It does not occur in Canada and has not been reported in Japan or most of China.

The Canadian species is *Latrodectus curacaviensis* (Müller) 1776, which was described from a female from Curacao in the Lesser Antilles. It has at least 16 synonyms, and in Canada has been called *mactans.* Levi describes its distribution as "the Americas from southern Canada to Patagonia including Galapagos Islands but apparently is absent in Mexico, Central America and Greater Antilles, and is more common in the temperate regions of north and south America. The greater number of *curacaviensis* specimens from northern, compared to southern United States, may be due to the comparative rarity of black-widows *(mactans)* in the northern states. The extreme commonness of *L. mactans* in the southern states probably discourages collectors from picking up black-widows." It occurs in 30 States of the Union, from those just south of the 49th parallel to Florida and New Mexico. In Canada, it has been collected in Ontario from Bruce Co., Dyer Bay; Lambton Co., near Oaksdale; Norfolk Co., Delhi; in Alberta from Medicine Hat; in British Columbia from Kamloops — many collections; Cascade, Wellington, Vernon, Vancouver by Nathan Banks; Summerland and Victoria—many collections. To these can be added the Gulf Islands and Lillooet, where a

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citizen reported it to me in January, 1961 as "occurring in thousands." I have found it on the Douglas Lake Ranch, in the Nicola area, and in Vancouver.

The dorsal abdominal patterns vary considerably, from coal black near the Pacific coast, to nearly white or very pale, with 6 black bars, in the Argentine. The largest males occur in Florida and the largest females in the Pacific States; the smallest males and females are in the Argentine.

Levi gives the habitat of *L. curacaviensis* as trees and shrubs in Florida, where *L. mactans* lives on the ground. In the northern States *curacaviensis* is found in fields and woods underneath logs and stones, usually away from human habitations. In the Nicola area I found its webs abundant in dark areas of horse stables, and in the Kamloops area at 3000 ft. (which seems to be locally its altitudinal limit), in little-used cabins, high on the walls. In Vancouver, I found it in the crawl space under a small house and in a basement at ground level.

The next 3 species are rare. *Latrodectus pallidus* O. P. Cambridge, from the Plains of Jordan in Palestine, differs from *mactans* only in habits and physiology, in its food, the location of its webs, the time of oviposition, the thermal death point and the degree of toxicity of its venom; morphologically, it is similar to *mactans*.

Latrodectus hystrix Simon is found only in Aden and the Yemen, and *Latrodectus dahli* Levi, n. sp., in Bushire, Iran.

This record of *Latrodectus* Walckenaer corrects my note on "The Black Widow Spider, *Latrodectes mactans* Fabr., in Vancouver" in Vol. 57 of our Proceedings, where the spelling was unfortunately taken from a volume on Medical Entomology, and now establishes our local spider as *Latrodectus curacaviensis* (Müller).

Acknowledgment

I am greatly indebted to Professor J. Adams for calling my attention to the article by Herbert W. Levi and for lending me his copy of the Journal in which it appeared.

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EDITOR'S NOTE

Readers and contributors will notice that the papers in this issue are in a new arrangement. This was suggested and discussed at the executive meeting of 9 March, 1961. Papers listed under Taxonomic and General have been scrutinized by one or usually more members of the Editorial Board; those listed under Economic have been subjected not only to scrutiny by three or more members of the Editorial Board, but also in some cases to competent outside referees in appropriate fields. The Board hopes that this policy will enhance the presentation and assure the quality of those important contributions, without narrowing the scope of the Proceedings by excluding papers of general interest.

Contributors will be interested in the following quotations from the minutes of the executive meeting of 9 March, 1961:

"The cost of reprints to authors unsupported by an Institution was discussed. 'Unsupported' authors were defined as those whose reprints are not paid for by the Institute concerned. Such authors if ordering 100 reprints or more, would in future receive 50 of these free and the rest to be charged at the regular price. Such unsupported authors would also

in future be allowed two plate blocks free. Any other concessions were left in the hands of the Secretary to decide as best seems fit under the circumstances."

"The format of a reprint order was discussed and the free page allowance to each author per Proceedings was increased from 10 to 12."

DISTRIBUTION OF TRIRHABDA PILOSA BLAKE (COLEOPTERA: CHRYSOMELIDAE), ATTACKING BIG SAGEBRUSH IN THE INTERIOR OF BRITISH COLUMBIA[1]

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Introduction

In 1960 and 1961, distribution surveys were made of *Trirhabda pilosa* Blake, unofficially named the sagebrush beetle, in British Columbia. Interest in this insect centers on its apparent ability to control big sagebrush, *Artemisia tridentata* Nutt. From 1954 to 1961, larvae and adults of this species have attacked the foliage of big sagebrush plants on more than 3500 acres of rangeland in the Kamloops area. About fifty per cent of the plants attacked have been killed.

Big sagebrush normally inhabits overgrazed or otherwise impoverished volcanic soils in the lower and middle grass zones (i.e. 1000-2000 and 2000-3000 foot elevations, respectively) on much of the rangeland in south-central British Columbia. It is considered to be native in the former zone and an invading weed in the latter. In most locations its elimination or retardation would result in improved stands of native grasses.

In July, 1954, Mr. Wm. L. Pringle, Agronomist of the Canada Range Experimental Farm at Kamloops, observed a two-acre stand of big sagebrush which had been severely defoliated. This was near the Lac le Jeune road, about six miles southwest of Kamloops (3). Close examination showed numerous small metallic blue beetle larvae feeding on the leaves of the sagebrush. Adults collected from this site were identified as *Trirhabda pilosa* Blake by Mr. W. J. Brown, Entomology Division, Canada Department of Agriculture, Ottawa (1). This identification was confirmed by Mrs. Blake, who described and named *T. pilosa* in 1931, from specimens taken in California, Nevada and Wyoming (2). She listed *Artemisia tridentata* Nutt. as the host. In British Columbia, an authoritative identification of *T. pilosa* was uncertain for a time, because three other species of *Trirhabda* also have been taken. Specimens of *T. attenuata* (Say) and *T. flavolimbata* Mann. have been collected from the Kamloops area and *T. canadensis* (Kby.) from the Vernon area. The first is very similar to *T. pilosa*.

Careful checking of the Canadian National Collection by Mr. W. J. Brown showed that specimens of *T. pilosa* had been taken in this province at Seton Lake, Nicola, Summerland, and Kamloops. The earliest record was a single specimen taken in the Kamloops area in 1890. Although these records indicate that the insect has been taken from widely separated locations, no early reports have been found which record defoliation of sagebrush similar to that noted by Pringle.

Methods and Results

In 1960 and 1961 surveys were made

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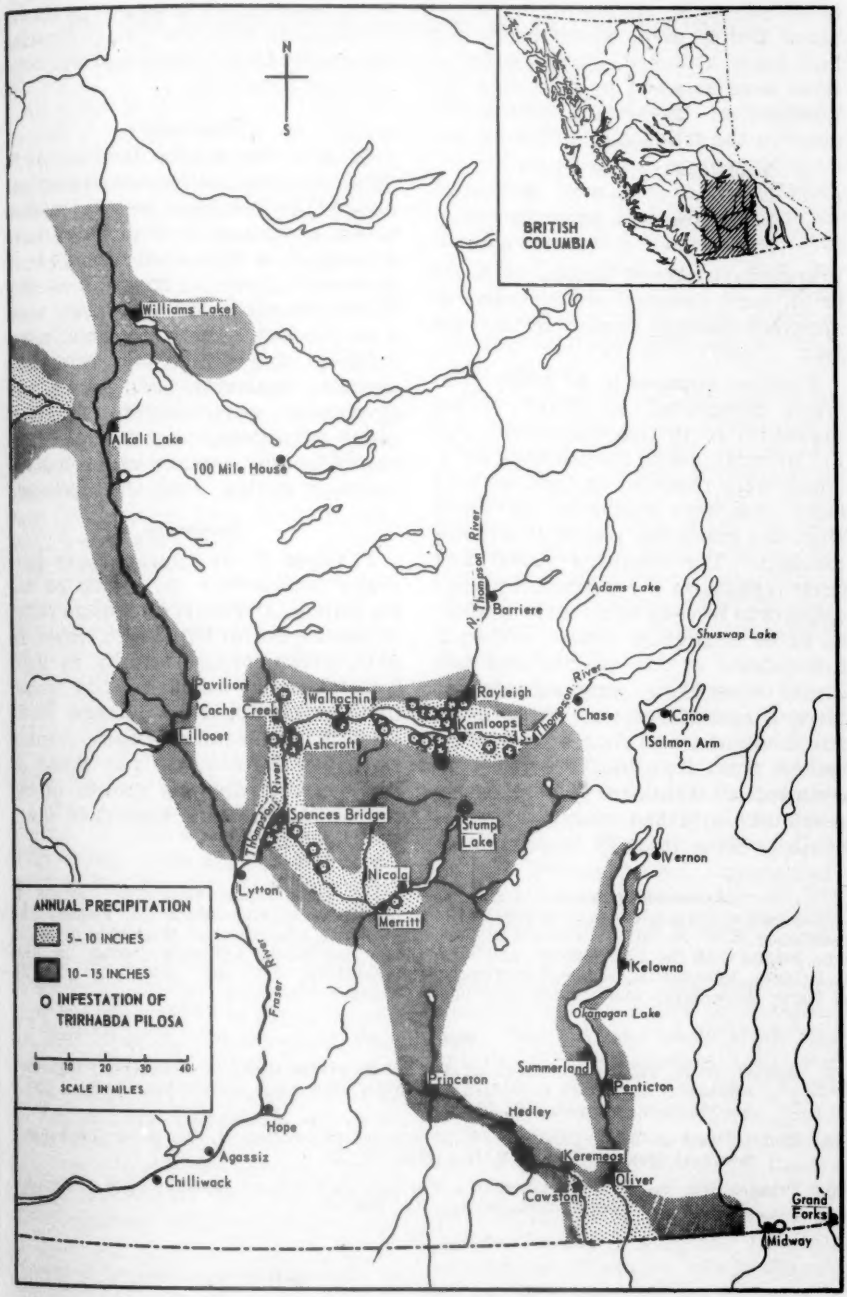

Fig. 1—Distribution of **Trirhabda pilosa** Blake in south-central British Columbia.

of *T. pilosa* in stands of big sagebrush and of areas which previously had been attacked. Active infestations were assessed by recording the numbers of larvae and adults per plant in the following categories:

Very light	—1 to 5
Light	—6 to 15
Moderate	—16 to 50
Heavy	—51 and over

Previously attacked stands of sagebrush were assessed on the basis of apparent damage caused by the insect.

T. pilosa appears to be fairly generally distributed in stands of big sagebrush in British Columbia. (Fig. 1). In most areas infestations of *T. pilosa* were recorded as light or very light and were restricted to fewer than ten sagebrush plants at any one location. The resulting larval and adult feeding on the sagebrush foliage appears to be causing so little damage as to be negligible. Single moderate infestations of one-quarter and two acres, respectively, were recorded at Merritt and Keremeos. Three light, one moderate, and four heavy infestations from four to 300 acres were recorded at Kamloops. There, three previously attacked stands of sagebrush ranging from 80 to 1500 acres were recorded as heavy. The heavy infestations indicate that stunting and death of big sagebrush will continue at Kamloops.

Discussion

To date, the sudden increase of *T. pilosa* has not been satisfactorily explained. It has been postulated that a new physiological strain may have developed, or that a hybrid may have developed from a crossing of two *Trirhabda* species present in the area. A single factor such as greater longevity of the adults and therefore greater fecundity, or particularly favourable environmental or host plant conditions, might explain the heavy feeding damage which has resulted in killing some big sagebrush.

Summary

T. pilosa Blake appears to be generally distributed in stands of big sagebrush, *Artemisia tridentata* Nutt., in south-central British Columbia. In most areas foliage feeding by light infestations of this insect has caused little or no apparent damage. However, in the Kamloops area, feeding by heavy infestations has killed or severely retarded the growth of big sagebrush on more than 3500 acres of rangeland.

Acknowledgement

The author acknowledges with thanks the assistance of W. A. Low, Student Assistant, who helped with the 1960 survey; and Wm. L. Pringle, Agronomist, Range Experimental Farm, Kamloops, who located and provided information regarding certain *T. pilosa* sites, and identified plants. The guidance and editorial assistance of Dr. R. H. Handford, Officer-in-Charge of this laboratory, are also gratefully acknowledged.

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HISTORY OF MOSQUITO CONTROL IN BRITISH COLUMBIA

C. L. NEILSON[1] AND L. C. CURTIS[2]

As early as 1856, J. K. Lord (7) collected mosquitoes in the Lower Fraser Valley of British Columbia and made pungent remarks on their abundance and habits. His determinations, however, were generally faulty. The first careful study of mosquitoes in the province was by H. G. Dyar (1) who visited the Kootenay district and Vancouver Island in 1903. In 1919 he made a journey through the northern part of the province, and collected from Prince George to Atlin (2). From 1899 to 1919 Fletcher, Trehearne and Hewitt made collections, all of which appear to have been submitted to Dyar for determination and publication.

In 1919 Hearle began a study of mosquitoes in the Fraser Valley in response to a request from the municipalities of the lower mainland for a mosquito control programme. In 1920 he published a preliminary report of his findings (4). This work concluded with a full report published by the National Research Council (5) and a published list of the mosquitoes of British Columbia (6). Within two years of the establishment by Hearle of the Livestock Insect Laboratory at Kamloops in 1928, mosquito control programmes were started at Kamloops and Kelowna. Interest in controlling mosquitoes grew over the next 15 to 20 years until by 1948 Gregson (3) reported that twenty-four communities were practising mosquito control. Since 1948 L. C. Curtis has continued mosquito investigations at Kamloops and has acted as a technical adviser. Since 1953 C. L. Neilson has collaborated with Curtis as technical adviser and encouraged Provincial Government participation.

The number of projects varies somewhat from year to year. This is largely because adequate control has not always been achieved on account of lack of funds or loss of key personnel in the district. At present there are twenty-five cities, towns, or districts actively engaged in mosquito control.

The largest control district in the province is that of the Fraser Valley Mosquito Control Board, which consists of the Municipal Districts of Richmond, Burnaby, Maple Ridge, Pitt Meadows, Coquitlam, Surrey, Langley, Matsqui, Mission, Kent, and Chilliwack, together with the City of Mission and the Village of Harrison Hot Springs. The annual expenditure is about $25,000.

In the Interior, the cities of Revelstoke, Kamloops, and Kelowna spend approximately $3,000 annually, while the Penticton budget is near $1,800. All have been engaged in mosquito control for about thirty years. Other cities doing control work include Kitimat, Prince George, Quesnel, and Grand Forks. Of the smaller centres, Merritt, Clinton, and Salmon Arm are active.

Other mosquito control work is carried out by the following organizations: Barriere and Louis Creek Mosquito Control Association, Little Fort Mosquito Control Board, Central North Thompson Board of Trade (Birch Island - Clearwater), Lower North Thompson Mosquito Control Committee, Sicamous Mosquito Control Committee, Solsqua Farmers' Institute, Malakwa Farmers' Institute, Arrowhead Chamber of Commerce, Wasa Mosquito Control Committee, Christina Lake Community Club, and Falkland-Westwold Board of Trade.

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It is expected that new control organizations will operate at Spences Bridge and in the Invermere district.

Areas that conduct sporadic control include Argenta, Golden, Norgate Park in North Vancouver near the First Narrows Bridge, Oliver, and Savona.

Control measures now consist mainly of larviciding with 1 per cent DDT in oil at 2-3 gallons per acre or with DDT in gelatine capsules ("Tossits")[3] or treatment of breeding areas before hatching with five per cent granular aldrin or heptachlor at 1-2 pounds per acre.

Larviciding by the use of aircraft is carried on as a regular practice in the Fraser Valley, and at Kitimat, Kamloops, the North Thompson Valley, and a few smaller areas as the occasion demands, and as money is available. Engine-equipped ground sprayers for both larviciding and adulticiding are used at Penticton, Kelowna, Kamloops, Revelstoke, Kitimat, Louis Creek-Barriere, Clinton, Sicamous, and Grand Forks. Similar equipment was used by the Fraser Valley Mosquito Control Board in 1961. Other ground work is largely done by knapsack sprayer, granular insecticides, or "Tossits." However, insecticide-treated sawdust is still used, and a few aerosol generators are operated from the exhaust of jeeps, trucks or tractors.

[3] Wyco Inc., West Palm Beach, Fla., U.S.A.

Financing of the various control operations has been largely by city grants, or in smaller communities by fund-raising activities and gifts. The Fraser Valley Control Board operates on funds contributed by the various bodies on a population basis, and the Federal and Provincial governments make annual contributions. The Provincial Department of Agriculture has for the last two years made very small annual grants to ten of the widely scattered rural districts in order to encourage their efforts. The grants afford the Provincial Entomologist an excellent opportunity to work with the communities to improve their techniques.

In conclusion, it is our belief that the time has come for Provincial legislation under which control areas may operate, raise funds in an orderly manner, finance the purchase of heavy equipment, and provide continuity of employment for skilled workers. It would give workers the right to entry upon lands for the abatement of mosquito nuisance, and protect individual workers from damage claims. At the same time, it would give affected property owners and ratepayers a voice in the direction of operations.

A further desirable development would be an association of mosquito control workers to provide means for administrators and operators to discuss the many mutual problems that may arise in this difficult field.

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NOTES ON THE LIFE HISTORIES OF FOUR MOTHS FROM SOUTHERN VANCOUVER ISLAND (LEPIDOPTERA: PHALAENIDAE AND GEOMETRIDAE)

GEORGE A. HARDY[1]

Orthosia pulchella algula Sm.

This species has an expanse of 35 mm., the primaries of uniform fuscous brown with a faint purplish reflection, the secondaries a dark smoky brown. Compared with some members of the genus it is somewhat scarce in my experience; I have taken only two specimens in more than ten years of study. The caterpillar very closely resembles that of *O. transparens* Grt. A specimen captured at light, at Royal Oak, on March 27, 1959 had laid 135 ova by March 30, in a close-set, single-layered batch on the side of the container.

Ovum

Size 1.0 mm. by 0.75 mm., a slightly depressed hemisphere with about 40 vertical ribs, the edges of which are closely indented, giving a bead-like appearance; pale cream, gradually becoming darker as development proceeds, with an orange dot on the micropylar area and an orange ring about midway. On a few ova the orange was replaced by dark purple. Hatched April 22.

Larva—1st Instar

Length 2 mm. Head pale brown. Body sordid white, translucent, with short, scattered hairs. They did not eat the chorion. They nibbled reluctantly at willow leaves, but not until most of the larvae had died was it found that *Arbutus menziesii* is one of the preferred food plants.

2nd Instar

May 8. Length 6 mm. Body pale chocolate-brown, with thin white dorsal and subdorsal lines, tubercles black and conspicuous.

3rd Instar

May 15. Length 12 mm. Appearance similar to first instar.

4th Instar

May 25. Length 18 mm. Head small in proportion, reddish-white thickly covered with white dots having black centres. Body red-purplish-brown, finely vermiculated with white; dorsal line indicated as a white dash on the centre of each segment; one or two very fine whitish lines just above the spiracular line, which is hardly discernible as a pale band; the tubercles black, white bordered.

May 31. Length 20 mm. Head whitish, tinged with purple, the vertex and sides brown, the latter mottled with lighter brown. Body smooth, dark purplish-brown, finely irrorated with a lighter shade; dorsal line white, and broken; subdorsal lines very faint, whitish; the tubercles black, white on the outer sides; underside, legs and claspers concolourus with upper side. They fed well on arbutus. When disturbed they snapped the head and forebody vigorously back and forth, and emitted an oral fluid when irritated. Noticeably geotropic.

5th Instar

June 6. Length 25 mm. Head as described. Body thickly flecked with fuscous and luteus dots on a background of flesh-colour; cervical plate dark brown, centred with a white continuation of the dorsal line; dorsal line white and broken; spiracular line dark grey, inconspicuous; legs pale brown; underside and claspers flesh colour. Full-grown by June 10.

June 17. Larvae burrowed into the earth in the jar, where they spun strong cocoons.

Pupa

Size 18 mm. by 6 mm. Smooth, shiny, dark brown. Cremaster two fairly stout spines, with slightly curved tips and 2 or 3 minute curl-

[1]Provincial Museum, Victoria, B.C. (Rtd.)

tipped hairs at the base, set upon the smooth tip of the last segment.

Imago

Emerged March 25, 1960.

Pleroma obliquata Sm.

Four species of the genus *Pleroma* are listed by Jones (1951) for British Columbia, three of which have been recorded from Vancouver Island. All seem to have a western American distribution.

They are medium sized moths with densely hairy bodies, a wing expanse averaging 35 mm., and are coloured in various shades of ash-grey, often in striking contrast. They come readily to light, but hide by day where their colour and markings render them almost indistinguishable from their surroundings.

A female *P. obliquata,* taken on April 4, 1959, had laid 25 ova by April 10.

Ovum

Size 1.0 mm. by 0.75 mm., obconical, strongly ribbed and cross-ribbed, cream at first, turning darker in a day or two, with a purplish-lead tinge, heavily streaked, and blotched with dark brown, chiefly between the ribs of which there are about 40. Became a dark plumbeous colour at maturity. The eggs hatched on April 27.

Larva—1st Instar

Length 2 mm. Head light brown, shiny. Body, a dark grey with short scattered hairs. Rested with thoracic segments raised sphinx-like. It fed on wax-berry, *Symphoricarpos racemosus.*

2nd Instar

May 2. Length 5 mm. Similar in appearance to first instar but darker in colour.

3rd Instar

May 6. Length 7 mm. Head dark, piceous brown. Body slender, humped on A. 8, greenish-grey with a broad whitish dorsal line, narrower subdorsal lines and supra - spiracular lines, a broad spiracular line, the cervical plate dark brown. Hump on A. 8 brown, legs brown, spiracles black; tubercles black, each bearing a short black seta.

4th Instar

May 10. Length 10 mm. Head light orange-brown. Body dark olive, lighter on the sides, with a broad white dorsal line ending on A. 7, narrow subdorsal and supraspiracular lines, A. 8 and 9, with a transverse white dash. Spiracular line broader than the subdorsals but not so wide as the dorsal line; underside darker than dorsal side.

5th Instar

May 20. Length 20 mm. Head honey-brown with suffused dark vertical patches on each side, shiny and with a few long thin hairs. Body with a dark chocolate band on dorsum containing a broad white dorsal line; dorsal line edged with black and threaded along the centre with a thin, interrupted, greenish line; sides dark cinnamon with several very thin whitish lines; orange spiracular line only evident on A. 7, 8, and 9; spiracles white, ringed with black; hump on A. 8 dark chocolate with a transverse white bar. Underside greyish with many longitudinal, rather faint, darker lines.

6th Instar

May 27. Length 30 mm. Head grey with a broad, dark brown, vertical bar on each side. Body brownish to reddish grey, with a broad fuscous band on the dorsum containing the white dorsal line with an orange, or rust-coloured, suffusion; sides light grey, spiracular line not well marked except on A. 7 to 9, where it showed as a dark band containing the white spiracle. A. 8 humped, with a dark patch on dorsum edged behind with a transverse white line.

By June 2 the larva was full-grown. The body tapered towards the head, which was held straight out and looked like a part of the body, since the subdorsal lines continued along the

side of the face. The dark dorsal band, containing the dorsal line, was constricted between segments, giving a wavy appearance to the band as a whole.

June 10. In the moss at the bottom of the container the caterpillar had constructed a tough, papery cocoon in which fragments of debris were incorporated.

Pupa

Size 15 mm. by 5 mm. Cylindrical, smooth, dull, and piceous. Abdominal segments with small, raised, irregular striae on the anterior margins; cremaster two very short, stout, divergent horns on a slightly rugose, conical base at the end of the last segment.

Imago

Two adults emerged on February 22, 1960, and five more on the next day.

Behrensia conchiformis Grt.

This distinctive moth has an expanse of 30 mm. The primaries are light grey with a dark central band containing a conspicuous white spot; the secondaries are light grey with a wide fuscous margin. It is usually taken at light during April and early in May.

A batch of ova was obtained on May 3, 1960, scattered singly on the sides and bottom of the container.

Ovum

Size 1.0 mm. by 0.75 mm. A truncate cone, with about 24 vertical ribs that produce iridescence according to the incidence of the light; white, gradually developing minute dark dots, chiefly on the upper part, some of which tend to form an indistinct ring round the upper third. Hatched on May 12.

Larva—1st Instar

Length 3 mm. Head opaque, white. Body opaque, dull white. They consumed the chorion, and were very active, looping like geometrid larvae. After trying several plants *Symphoricarpos racemosus* was accepted.

2nd Instar

May 19. Length 5 mm. Head as described, with small black dots bearing setae. Body bluish-green from the food ingested; subdorsal and supraspiracular lines indicated by faint dark lines; spiracular line bluish-white, bordered by thin dark lines; A. 8 slightly humped. Rested with the head extended in line with the body on the edge of a leaf or along a stem, where they were difficult to detect at a glance.

3rd Instar

May 26. Length 15 mm. Head pale bluish-white, streaked with light brown, with sparse, coarse hairs. Body slender, with a slight hump on A. 8, pale bluish-white; dorsal line faint, double, milky-white; the sides lighter than the dorsum, with 3 thin pale brown lines; spiracular line white; underside sordid white with a light brown spot on the centre of each segment; legs and claspers colourless, outer side of claspers with several black dots.

May 29. Length 18 mm. Head pale whitish-brown speckled and streaked with light brown. Body grey-green, faintly marked with a double, milky-white dorsal line; below this on each side, four very thin whitish lines; underside pale grey-green streaked with beige; tubercles very small black dots, each bearing a seta.

4th Instar

June 1. Length 22 mm. Head beige, dappled with light brown. Body greyish, with ochre tinge on dorsum; darker on sides; dorsal line a faint, creamy double line coalescing on A. 7 and 8, the latter slightly humped with fleshy processes on each side, each bearing a seta at the tip; three or four thin,light lines above the spiracular line which was indicated by a thin line on which were the small, white, black-rimmed spiracles; three or four thin, light lines below the spiracular line; underside paler than

dorsal side; claspers with black dots on the outer sides.

June 4. Length 30 mm. When at rest they lay straight along stems which they superficially resembled, resulting in perfect camouflage.

June 10. Length 45 mm. The larvae full-grown. Head greyish, resulting from light brown freckles on a beige base. Body light brown with a faint tinge of ochre; sides lighter; dorsal line milk-white with a suffused brownish thread down the centre, more decided on A. 8 and 9, where it continued between the two short, seta-bearing papillae; spiracular line similar to the dorsal line, edged above with black on which were the spiracles; underside pale with several fine lines.

June 18. Pupated in cocoons spun on the leaf surface. Comminuted fragments of leaves were incorporated in the cocoon, which blended into the background as a result.

Pupa

Size 15 mm. by 4 mm. Cylindrical, tapering off for the last two or three segments; semi-glossy; the wing-cases minutely wrinkled; anterior part of the segments closely and coarsely punctate; dark brown, with a fuscous shade on the wing-cases. Cremaster two very minute, widely spaced divergent projections on an elongate, rugose, conical base.

Stamnodes blackmorei Sweet.

This small geometer has an expanse of 21 to 27 mm., and is of somewhat subdued colouration. It is pale cream with a satiny lustre, the primaries with some light brownish patches, chiefly along the costa and tips. In females these patches extend over the wing, with a noticeable U-shaped one on the middle third. The secondaries are devoid of markings on the upper surface but below have two brownish spots, one on the inner margin, the other near the anal angle.

My attention was drawn to the early stages when several larvae were found feeding on waterleaf, *Hydrophyllum tenuipes*, at Goldstream, in May, 1958.

In July, 1958, ova were obtained from several specimens but none hatched. On April 28, 1960, larvae in nearly all stages of development were taken by sweeping the food plant. From these the following sequence was worked out.

Ovum

Size 0.75 mm. by 0.50 mm. An obtuse oval, smooth, with very obscure microscopic reticulations; chalky-white to pale cream. They were laid loosely, or so weakly attached to a leaf as to be easily shaken off. Three batches consisted respectively of about 30, 20, and 27 ova. They were laid from July 3 to 5. A few ova were obtained on August 6, 1960.

Larva—1st Instar

Length 2 mm. Head green. Body semi-translucent, green, without markings.

2nd Instar

Length 5 to 10 mm. Head smooth, shiny, whitish-green, semi-translucent. Body pale green, subdorsal lines, supra-spiracular and spiracular lines thin and yellow, with several fine, broken lines between; a decided fuscous bar along the dorsum of A. 8 and 9.

3rd Instar

Length 18 mm. Head pale green. Body apple green, subdorsal, supra-spiracular and spiracular lines indicated by irregular rows of whitish dots; A. 8 and 9 with a strongly marked fuscous bar along the dorsum; intersegmental rings yellow; spiracles black; tubercles minute, black on white bases, seta-bearing; underside pale green; body noticeably constricted between the segments.

4th Instar

Length 22 mm. Head pale brownish-green, dotted with black in four indistinct, vertical lines. Body green;

dorsum of segments with sagittate fuscous marks pointing forward, accentuated on A. 7 to 9; subdorsal lines thin, yellowish; spiracular area whitish with margins blending into the ground colour; spiracles black.

Some larvae had the sagittate markings widened to extend over most of the dorsum, with the ground colour sometimes very dark brown; the underside chocolate brown.

When at rest they lay curled up on the underside of the leaf, dropping to the ground if disturbed, or occasionally, when only slightly alarmed, raising the fore part of the body sphinx-like.

May 5. Pupated in a slight cocoon at the bottom of the container.

Pupa

Size 8 mm. by 3 mm. Smooth; the abdominal segments strongly punctate; green at first gradually changing to brown; the cremaster two divergent, stout, very short spines at the tip of a flat projection on the dorsal side of the last segment.

Imago

Two emerged on June 1, one on June 6, and one on June 9, 1960.

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A RECORD OF SLUGS IN VANCOUVER GARDENS

G. J. SPENCER[1]

At the end of August 1959 we moved to another house in West Point Grey and before long it was evident that slugs were common in the garden. In the 18 years that we lived in the previous house, I had found and slain 6 slugs only so I asked the previous owners of the new house if they had been troubled by slugs and was told that they had seen less than a dozen. With a flashlight I collected and killed an uncounted number in the autumn of 1959, and throughout the season 1960 I estimated that I took between one and two thousand without seeming to reduce the population.

As soon as the creatures emerged from hibernation in March, 1961, I kept track of the numbers taken and from their first appearance to 29 July, I obtained 3158 slugs and 49 snails, collected as follows: March, 73 slugs and 8 snails; April, 558 and 12; May, 1271 and 15; June, 654 and 10; July, 602 and 4. By the middle of June the small native species of slugs began to appear, so for 2 weeks in June and 4 weeks in July, they were counted separately. They totalled 357 large and 681 small; of this number of the small species, 320 were taken on July 5 after 24 hours of pouring rain.

These slugs and snails were very kindly identified for me by Mr. R. J. Drake, Malacologist and Archaeologist with the Canadian National Museum who is currently working out from this University.

They fall into two groups: those that have come in from Europe and are rapidly reaching outbreak proportions, and our native species. Of the former, *Arion ater* (Linne) is by far the most common of the large, 3-inch slugs occurring locally and is in two forms: uniformly shiny black, and dark or light brown. They are the earliest to emerge from hibernation and feed on the new shoots of a number of garden plants, largely iris and daisies. An even larger slug occurring in much smaller numbers is *Limax maximus* Linne which is thin and long, reaching 5 inches when fully expanded. It is conspicuously spotted around the head end, with 3

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rows of black spots down the body. It occurs in one corner of our garden only, near the compost heap. This species has long been in western North America but originally came from Europe. The third immigrant is the snail, *Cepaea nemoralis* (Linne) which has a wide range of color patterns from uniformly yellow or yellow and brown, to having three wide or narrow conspicuous black lines following the spiral. This snail climbs high up on vegetation at night and hides on the ground by day.

The second group, of native species occurring locally, includes the largest of all, *Ariolimax columbianus* Gould. This reaches a length of over 6 inches and is brown or green with large or small irregular black blotches on the back, sometimes so close together as to make the slug look black. It is the chief slug of Stanley Park woods, to be found anywhere along the walks or paths. It occurs mostly in gardens that have recently been dug out of the bush and has not turned up so far in my garden.

Another native species is the little pale brown, grey, or dirty white *Derocerus reticulatus* (Müller) which is 1 to 1½ in. long, fully expanded. This slug does not show up until June but probably starts earlier in the season and is overlooked on account of its size. It seems to be largely a grass feeder but climbs iris, gladiolus and montbretia leaves and rasps off the upper epidermis. It occurs rarely on fine warm nights but swarms out during and after rain.

The size of this population in one garden is remarkable. Our lot is the average for this street, being 60 x 120 ft. from sidewalk to rear lane. In front, the property has a lawn on each side of the concrete approach and a flower bed against the house. At the back, 18 feet is taken up with a concrete drive to the garage under the house and the rest consists of lawn with a flower bed 4 ft. wide on three sides. At irregular intervals I patrolled the territory with a flashlight, following the same course every time and counting only the specimens that occurred on my property. Last summer I must have killed well over 1000 slugs and yet the count is over 3000 this year up to the end of July. The previous owners were apparently unaware of this infestation and it is remarkable that there was any garden left at all. Some of the slugs undoubtedly moved from the garden next door where the vegetation is rather rank.

The Control of Snails and Slugs

Snails at the present are scarce and occur singly; they are readily crushed under foot.

Slugs are favoured by rank growth either in garden beds or in brush alongside; therefore clean cultivation keeps down their numbers.

Salt sprinkled over a slug's body produces a tremendous outpouring of slime and kills it fairly rapidly. If insufficient salt is used, the slime keeps off the salt and the slug moves away.

Fifty or so slugs in a basin, shaken up with an ounce of gasoline, die almost immediately; even the fumes of gasoline in an enclosed space, will kill them.

The standard commercial bait of metaldehyde and calcium arsenate, in pellet form, is extremely effective; poisoned slugs seldom move more than one foot from the bait.

I have found that a pound of fish cat food mixed with an ounce of calcium arsenate or white arsenic, is very attractive to slugs. The mixture should be rubbed on the sides and bottoms of empty cans and the tops squeezed nearly flat so that cats and dogs cannot get at the bait but slugs can creep in between the edges. This costs 10c per tin for cat food and a variable amount for the arsenic and is the cheapest bait that I have evolved so far.

THE GROWING PROBLEM OF POLLINATION IN BRITISH COLUMBIA FROM THE POINT OF VIEW OF EXTENSION ENTOMOLOGY

J. C. ARRAND[1] AND J. CORNER[2]

Extension work in the field of pollination, even with the large amount of research information available (Bohart [1960], Free [1960], Todd & McGregor [1960]), is difficult. The effects of adequate pollination are only realized when yields over a period of several years are considered. The results of a single field demonstration may be obscured by uncontrollable factors, such as weather, the general physiological condition of the plant, competing bloom, or the population level of wild pollinators. As a result, an important extension tool is often rendered ineffective. Furthermore, because of the complexity of the problem, many growers develop the attitude that with or without pollinators successful yields are largely a matter of chance. For example, the yields of legume seed in the Peace River district of Northern British Columbia fluctuate considerably from year to year. The yields of crops that are adequately pollinated tend to be higher than the district average. However, the fact that the variability is general suggests to many growers that the success or failure of the enterprise lies outside their control.

In some areas a reasonable wild or honey bee population exists and the growers obtain fair or good yields of self sterile crops without any special effort. Under these conditions it is difficult for the individual to accept his responsibility for preserving the pollinators. It is even more difficult for him to realize that an increase in the number of pollinators could result in increased yields, better quality and more even ripening.

The fruit- or seed-grower and the beekeeper often fail to understand each others' problems. The beekeeper in the Okanagan may feel that the orchardist is spraying dangerous insecticides unnecessarily and indiscriminately. The seed grower in the Peace River district may feel that the beekeeper is getting something for nothing and should pay for putting bees near the field. Bringing these two groups to a common point of understanding is a major part of the extension program in pollination.

A discussion of the program in British Columbia including what has been done, future plans and where research can help, is best considered under the main crops involved.

LEGUMES

Several methods have been used to give growers the facts on legume pollination. For the past three or four years considerable information has been included in the annual short courses in beekeeping in the Peace River district, and meetings for beekeepers and seed growers have been held. Several formal addresses have been presented to the British Columbia Seed Growers Association and to the British Columbia Honey Producers Association. An exhibit on pollination was prepared and exhibited at fall fairs. Two pamphlets, "Insects and Legume Seed Production" and "Clover Seed Growers, Why Gamble? Use Bees", have been written and distributed. A successful demonstration, described in this paper, of planned pollination of alsike clover has been conducted.

Alfalfa

In Canada the economic production of alfalfa seed depends on the population level of certain species of wild bees. Honey bees are able to obtain

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nectar by going into the side of the flower and consequently they "trip" only a small percentage of the flowers visited. They obtain pollen from other sources. Extension efforts to conserve wild bee nesting sites have been almost helpless against the economic facts which demand that the grower clear and break more and more land so that cash crops can be planted. The result has been that alfalfa seed production in the Peace River district has followed the familiar trend described by Stephen (1955). As the acreage increases the yields drop, growers are forced to turn to other crops, and alfalfa becomes confined to the hinterlands.

Future extension programs will probably depend on one or more of the following developments:

A. Establishing areas for alfalfa seed production where the wild bee population can be conserved.

B. Developing practical methods of semi-domesticating wild bees.

C. Finding ways of forcing honey bees to pollinate alfalfa under our conditions.

In the meantime extension efforts will have only a very limited effect.

Alsike and Sweet Clover

Alsike and sweet clover are readily pollinated by honey bees and are good nectar sources. Consequently more extension progress has been made in the pollination of these crops than in the pollination of other legumes. An increasing number of seed growers in the Peace River District are realizing the value of honey bees on alsike or sweet clover and are urging beekeepers to put colonies near their fields. They are not yet, however, willing to pay for the bees either in cash or on a share crop basis. The beekeeper is therefore necessarily concerned only with honey production, consequently he tends to use insufficient colonies for good pollination. Furthermore, he brings the colonies in before the fields are in bloom and does not space them — factors which greatly influence their effectiveness. It is important that the alsike or sweet clover seed grower and the beekeeper fully appreciate each other's position.

As a part of the extension effort a demonstration of alsike pollination was conducted in the Peace River district of Northern British Columbia.

On July 18, 1960, at Mile 24 Alaska Highway, forty colonies of honey bees were set out in 65 acres of alsike isolated by about 3 miles from other legumes. This acreage consisted of three adjacent fields of 20, 30, and 15 acres respectively. The colonies were spaced evenly around the centre 30 acre field.

By early September the seed had ripened evenly on all three fields. An average of 450 lb. of clean seed per acre was harvested as compared to an estimated district average of 250 lb. per acre. The most impressive feature was the appearance and quality of the seed.

It is interesting to note that the honey yield was 160 lb. per colony. The district average was 150 lb.

Red Clover

Red clover pollination presents several special problems. Although certain species of bumble bees are ideal pollinators, they are seldom present in large enough numbers except in newly settled areas. It has been pointed out elsewhere in this paper that attempts to conserve wild bee populations have generally proved futile. Honey bees are good pollinators of red clover if they are used in large enough numbers and if competing bloom is kept to a minimum (Bohart 1960). Unfortunately, beekeepers avoid putting colonies on red clover because it is an unreliable nectar source. The use of honey bees on red clover has to be consciously and specifically for pollination. Consequently, widespread acceptance of planned pollination on red clover will probably come only after it is an

accepted practice on sweet or alsike clover.

FRUIT TREES

There is a large amount of research information on tree fruit pollination (Free 1960). However, the fact that little of the research has been conducted in British Columbia is a serious handicap to the extension worker.

Where the need for increased pollination is obvious, as with plantings of Red Delicious apples, cherries, and pears, certain fundamentals can be applied. For example, it is well known that honey bee colonies should be brought in after and not before the beginning of bloom. Several other questions are, however, impossible to answer. What is the value of hand collected pollen? Are beehive inserts more effective than hand applicators? How should honey bee colonies be spaced in the orchard? What are the effects of prevailing winds in pollination? In many cases the information from different areas on these questions is not in agreement.

The importance of pollination is sometimes unclear. McIntosh apples, for example, generally have an overset of fruit. With this variety, however, would there be an improvement in quality and evenness of ripening if the king blossoms were set up quickly, even though thinning sprays were used subsequently?

There is also a lack of basic information on such questions as the foraging area of worker honey bees under various conditions. It is evident that only limited extension work is possible until an increased amount of research is conducted under local conditions and until more basic information becomes available.

THE PROBLEM OF INSECTICIDES

The widespread use of insecticides has no doubt been a factor in pollination in the Okanagan Valley fruit growing area. The chemical poisoning of honey bees except from the arsenicals has probably not been great, but in recent years some losses have occurred (Arrand & Corner, 1959). Partly because of a fear of insecticides, some beekeepers are moving their colonies to other areas. This along with the probability that wild pollinator populations have been reduced has increased the importance of planned pollination in this area.

During the past few years in British Columbia, beekeepers have been informed, by various methods, of the toxicities of new orchard chemicals and of possible ways of avoiding bee poisoning. Abstracts of pertinent papers have been mimeographed and distributed and the problem has been discussed fully at several beekeepers meetings. However, there has been little attempt made to bring the problem to the attention of fruit growers other than the warnings in the spray calendars.

Research can aid by giving more attention to the bee toxicity aspect of new chemicals that are being tested. The subject appears to be of increasing interest to researchers in other areas (Johansen [1960]; Anderson and Atkins [1959]).

BLUEBERRIES

Research information from other areas indicates that there is considerable variability in the self-fruitfulness of high bush blueberry varieties. However, the stigma of the flower on all varieties protrudes considerably beyond the anthers and regardless of the degree of self-fertility, bees are important in transferring pollen (Merrill, 1936). In addition, there is fairly general agreement that cross-pollination increases the size of berries and the earliness of ripening.

Once again extension is handicapped by a lack of information under local conditions and with local varieties. Many growers in the blueberry growing areas feel that their crops are not being adequately pollinated and are asking for information.

MISCELLANEOUS

In British Columbia the pollination of cranberries, greenhouse cucumbers, melons and holly has had little attention by research or extension workers.

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MUSINGS OF A RESEARCH OFFICER, AGRICULTURE (ENTOMOLOGY)

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Entomological research in Canada grew from virtually nothing in 1918 to a well organized profession 40 years later. There were at first more positions to be filled than trained entomologists to fill them, and so men with some background in zoology, and even amateur insect collectors, were pressed into service. It was not by chance that a number of those entomological pioneers were born in England, or were sons of English parents. The English, generally speaking, have a more lively interest in insects and other aspects of nature study than Canadians. Since the beginnings of entomology in this country at least nine of our universities have instituted Departments of Entomology, or courses in Entomology. The colorful day of the amateur entomologist turned professional is over.

Since many of the early problems in entomology had to be solved quickly and with no nonsense, the pioneers of the science tended, on the whole, to emphasize the practical viewpoint; and they did well with it. Then, as the more straightforward problems were cleared up, attention had to be paid to less obvious issues. There arose a growing band of bright and shining young college graduates complete with Ph.D. degrees and a tendency to regard their predecessors as well intentioned but really somewhat ignorant chaps. One scintillating mind has summed it up in a word—"nozzle-heads", he calls the pioneer entomologists and those of his contemporaries who work in applied research.

Entomology in much of the western world has been going through a sort of scientific adolescence, a period when on the slightest pretext, the amateur statistician churns his experimental results in an electrical calculator until finally they butter into some sort of statistical odds. There is an urge to substitute statistical formulae for common sense. Even simple bits of research may emerge so gaudily bedecked in statistical finery that only a knowing few would ever guess their true stature. Perhaps the entomologists, and other biologists, have been moved to strive for profundity in the belief that if the layman can comprehend it can't

be science. Public awe of the mysteries of atomic science may have played a part here too.

Happily there are signs that Judgment, queen of human attributes, may be coming back into her own. What, in the argot, might be called the beatnik period of agricultural science seems to be on the wane. Of late more papers have been appearing in which the author, defying fashion, has been content to state in plain English the conditions of the experiment and the results. Readers have been given credit for sufficient intelligence to assess the results without recourse to mechanical predigestion.

Numbers of our agricultural scientists come from the towns and cities, and have never known the vicissitudes of farming. Although they might protest the point they have the townsman's outlook on farming, a profession that can be carried on successfully by an intelligent man with but little formal schooling. More by their actions perhaps, than by their words, they emphasize that they are scientists first, agriculturists second, and farmers not at all. Since the promotions of scientific workers in farming are not authorized by the farmers themselves it is not surprising that the agricultural scientist can drift away almost completely from the realities of life on the farm yet do better financially than if he had busied himself with the farmer's worries. Those of us who may be a trifle cynical have often noticed a tendency to identify intelligence with the business suit or, more particularly, with the white laboratory coat. But, in fact, the agricultural scientist has good reason to respect the ability and intelligence that are required for successful farming. Likely as not numbers of the so-called dirt farmers for whom, in the long run, he is working are at least his intellectual equals if not his superiors.

In the administrative circles of agricultural science there is an understandable proneness to equate a research worker's ability with the number and apparent profundity of his publications. The trouble is that to award a quid of salary for a quo of productive effort is to some degree a subjective matter as well as an objective one, and the administrator may be hard put to assess either aspect accurately. One of the crying needs in agricultural research, as indeed in many another field of human endeavour, is a better method of estimating the value of an individual's work to his fellow-man—some reliable means of stripping off the showier trappings of erudition and exposing what's underneath. This hardly seems to be the sort of job that the computer people will ever be able to solve; but maybe it is just as well that intrinsic human worth is not susceptible to mathematical analysis. In any case granting that every research worker should have to produce evidence that justifies his salary, today's pressure to publish can hardly be considered a boon to science. Certainly the literature of agricultural science, including entomology, is coming to wear pretty baggy britches. Its bulk seems to be greater than the substance warrants.

These remarks can be summarized in a few words. They urge less humbug in agricultural research, and more understanding of the farmer's problems. They urge less concern with the pay cheque, and more concern with a good day's work.

BOOK REVIEW

All things come to those who wait including, nowadays, almost every worthwhile book in a paper backed edition. 'The Forest and the Sea' started life in a hard cover; now it appears, well printed, at sixty cents as a Mentor Book (New York: New American Library, 1961, 216 pp.).

The importance and pleasure of this textbook of ecology are in no way diminished because most of the ideas, examples, and conclusions are not original, although it is fair to say that the best writing is in the author's references to his own experience in Albania, Colombia, central America, the south Pacific, and the West Indies. In a useful summary by chapters, nearly 70 sources are given, of which Bates remarks wryly that he has ". . . tried to observe the faint boundary between research and plagiarism . . ."

In fact much of the material is thoroughly familiar or even elementary, and for this the author rightly makes no apology. Essentially he has written an introduction to ecology, and it is the distillation of ideas with examples that is important. The book represents the content of an undergraduate general education course, "Zoology in Human Affairs," at the University of Michigan where Bates is a professor. Often one is aware of the author speaking, generally in the first person, as a wise, experienced biologist, giving his personal views to second-year students. The writing is discursive, eminently readable and never pedantic. In passing he rap the knuckles of professional ecologists for their addiction to coining words.

The title is from an interesting if not very useful analogy developed at some length, between the various layers of the forest and the sea, from the treetops or surface, to the floor or benthos. But the forest discussed, despite a conifer on the jacket, refers to mature, equatorial rain forest, such as most of us will never see.

The author refers to insects with authority, having worked for 25 years on malarial and yellow fever mosquitoes. Using an example of *Anopheles* in Albania, he presents a good discussion of speciation. From a single species, according to conventional taxonomy, no less than 7 non-interbreeding populations were sorted out, separable only by spots on their eggs and different tastes in hosts.

Bates makes a good case for more emphasis on what he calls 'skin-out' biology, the study of organisms as such, rather than 'skin-in' biology, the study of organs, cells and processes. The last few chapters deal with the evolutionary background and ecology of man, and the book ends with a plea for more intelligent conservation and better understanding of biology as a whole.

'The Forest and the Sea' should be required reading for ecology students, recommended reading for students of ecology.

—*H. R. MacCarthy*

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